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CAPTAIN E. G. FISHBOURNE, R.N. C.B. in the Chair.

PHOTOGRAPHY, AND ITS APPLICATION TO MILITARY PURPOSES.

By CAPTAIN DONNELLY, R.E. Inspector for Science, Science and Art Department, South Kensington.

MY lecture this afternoon, as you are aware, is on the subject of photography, and its application to military purposes. I would wish to guard against the supposition that might arise from the title, that I proposed to bring forward any new or remarkable application of photography to military art. I do not come before you as an inventor. I am not going to propose to defeat armies, destroy fleets, or take fortresses by the aid of nitrate of silver and the camera obscura; but I will endeavour, in the hour which is allowed me, and beyond which I hope I shall not draw on your patience, to explain as clearly as I can the general principles of photography, an art which is every day rapidly extending, and the aid of which may, I believe, be usefully enlisted in many secondary military operations.

In speaking of photography as an art, it must be understood that I do not wish to tread on the delicate ground of its status as a fine art, but I am employing the term art in its wide general signification, viz. the execution of works of all kinds. Our power of executing a photograph, or indeed any work, depends on our taking advantage of certain powers in nature which produce certain effects. The relation between these powers or causes and their effects, it is the province of science to investigate—to deduce and establish the fact of a certain sequence of events, or what we term the laws of nature; and then the same truth, which is a principle in science, becomes a rule in art.

In addressing you on the subject of photography, there are then two wholly distinct points of view from which I may look at the subject. Either I may consider the scientific principles on which photography rests, and how these truths are the rules of our art; or I may direct your attention to the application only of our *rules* to the production of photographs, paying little heed to their existence or general truth as principles. As, for instance, in regarding the steam-engine, we might, on the one hand, examine the mechanical principles and physical laws on which the machine works; or, on the other hand, we might confine our attention to the details of construction, or the stoking and driving.

I have preferred, and I hope I am justified in so doing, the former course; I believe it will be more interesting generally. Both are equally important; indeed the latter, the examination of details, is perhaps the most important, as we cannot produce a photograph, with a perfect knowledge of principles, without a thorough knowledge of details; but at the same time it would be impossible in one lecture to treat of both. The details are most fully given in many hand-books on photography, such as Hardwich's, and given from the result of experience ten times greater than I can boast of, and far better than I can give. But at the same time from the aim of these works—to enable the reader to become a practical photographer—it is difficult to obtain at first a general knowledge of the principles from them, as the statement of the principles is constantly interrupted by a description of manipulative details. I have, therefore, disregarded these details: it would be very wearying and quite useless, to give a number of photographic formulæ without at the same time actually manipulating a photograph ; while I hope a slight general knowledge of the principles may be interesting and useful to many officers, if at any time they wish to take up the subject practically.

In conclusion, I propose to mention some applications of photography to military purposes: these are at present not very numerous; but these instances will, I trust, protect me from the appearance of assumption in lecturing on a subject which many non-military photographers who have paid it far greater attention would be better able to handle. I have undertaken the subject with great hesitation, and only because I believe that it may often be applied with great advantage to the service.

Photography includes all processes in which pictures are taken by the action of light.

These processes are very numerous: in some different substances are used for the sensitive film, in others the same substances are employed under different conditions. As it would be very confusing to revert from one to the other, I propose taking the ordinary or most generally employed process as a type, and explaining it.

We will therefore take the wet collodion process, and its accompanying printing process on paper.

It is not my intention to assume that you know anything of photography, and as there may be some present who have never watched a photograph being taken, I may be permitted to define, as it were, what I am going to explain, and roughly to show the various stages of a photograph: the effect of each step I hope afterwards to explain.

I have here a camera. It must not be fancied that there is any peculiar photographic action or virtue in a camera. I cannot now explain

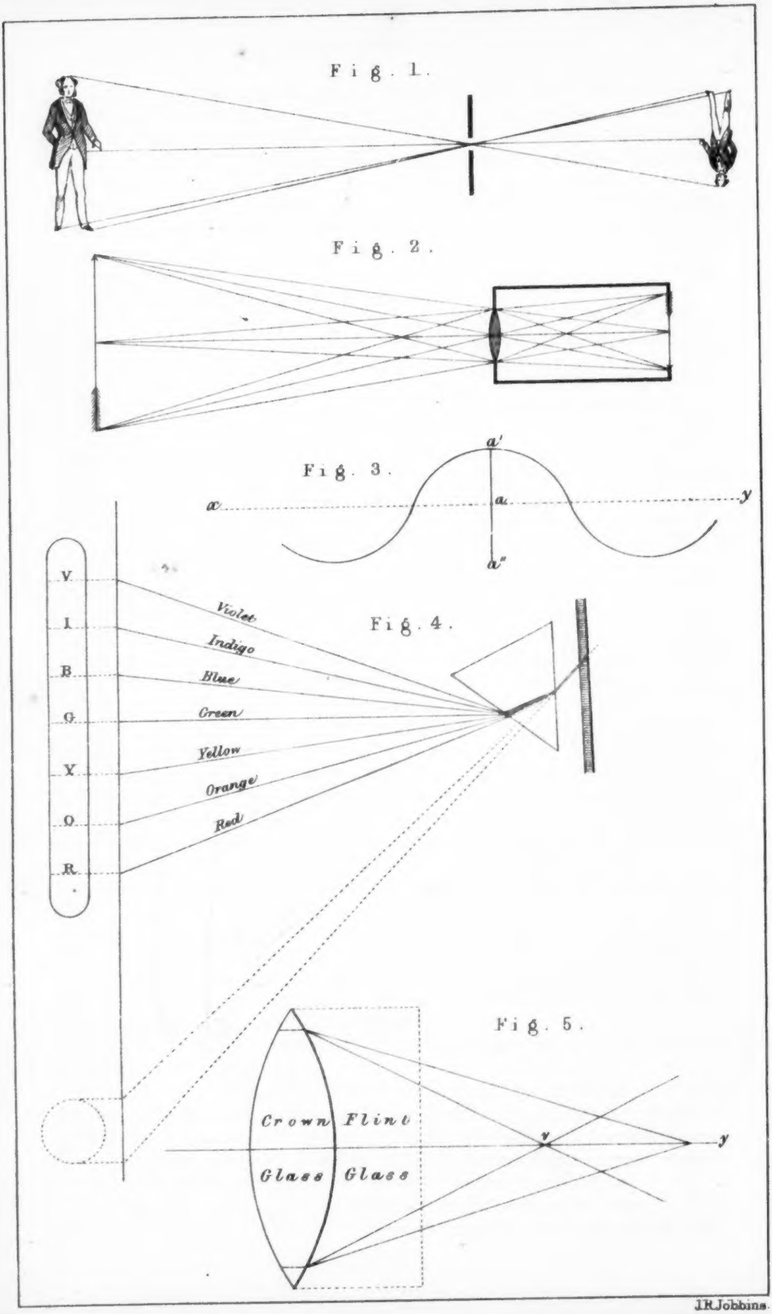
Fig. 1.
Fig. 2.
Fig. 3.
a'
x
a
y
a''
Fig. 4.
V
I
B
G
Y
O
R
Violet
Indigo
Blue
Green
Yellow
Orange
Red
Fig. 5.
Crown Flint
Glass Glass
v
y

J.R.Jobbins.

the optical principles of a lens, but I think the action of a camera may be readily understood from that of a telescope or opera glass. When we look through a telescope we have a distinct image, slightly magnified, of the objects on which the telescope is directed; that is, the eye, instead of looking at the objects directly, is examining the picture of the objects formed by the telescope. Now, the telescope consists of two distinct portions; the object or front glass forms the image or picture, and the eye-piece magnifies the image in order that we may examine it the better. In the camera we do not employ the magnifying or examining portion. If we place a screen in its place, that is, where the rays come to a focus we have still a picture of the objects formed. Now this, the telescope with the eye-piece removed, is the counterpart of the camera; instead of the tube of the telescope we have a box, with the object-glass fixed in it; the picture is then formed on this ground-glass screen. Having formed our picture, that is, focussed the camera, and so on, in place of the ground-glass screen we place the sensitive film; the picture is formed on it, and by the action of the light impressed on the sensitive substance. (By means of diagrams, figs. 1 and 2, and an explanation which it is unnecessary to enter into fully here, as it may be found in any elementary treatise on optics, it was shown how the image is formed in a camera.

How, for instance, in a darkened room, if a small hole be made in the shutter, an image of the illuminated objects in the street will be formed on the opposite wall, but reversed in consequence of the rays of light crossing. How, by diminishing the opening, the image becomes better defined at the expense of its illumination, till perfect definition could be obtained by the admission of only one ray.

This simple form of camera not being adapted to our purpose where strong light is required, how the difficulty is overcome by the lens, which catching, as it were, a large number of diverging rays from each point of the object, bends them together to one point—the focus, except in so far as spherical aberration comes into play, by which means we obtain a well-defined and at the same time well-illuminated image.

And further, that rays coming from points at different distances are not brought to a focus at the same distance from the lens, that is, in the same plane; and hence distortion of hands and objects in the foreground.)

I have here a piece of white paper with the word "object" printed on it in black.

Suppose I photograph it.

From all the white portions rays of white light are transmitted on to the lens, and brought to a focus in the camera on the ground glass.

From the black portions, speaking roughly, there are no rays: black being the absence of light. So that, if we place a sensitive substance in the place of the screen, we have light acting over some parts—those that correspond to the white parts of that paper, and no light on those portions which correspond to the black letters.

The light having rapidly produced a certain change in the portions on which it has acted, I remove the plate to the dark room, continue the action by applying certain chemicals, and having thoroughly changed or reduced these portions that have been acted on, I apply what is called a fixing agent, that is, I remove all the unchanged portions—those portions which correspond to the black letters.

The action of the light and chemicals has been to make the portions which were semi-transparent before wholly untransparent. I have then a glass with a coating all over except where we have the word "object" (reversed), with the portions of the glass that answer to the black letters transparent, the other portions opaque and dark.

If we hold this up and view it by means of transmitted light, what was dark in the original is here shown transparent. This then is called a "negative." If we place this on sensitive paper and expose it to the light, the light will pass through these transparent portions, and, acting on the sensitive paper, blacken them—this will be a positive; and from this one negative we can produce any number of positives.

The action is the same if, instead of the printed word, we had a landscape or a portrait to take; for, from the whitish skin, rays of light would be transmitted, and from the hair and eyes, if these were black there would be no light, except in so far that there are bright spots of light reflected from the moisture of the eye, and patches of light from the hair, especially if this is artificially glossy; however, to this I shall again have occasion to refer—I mean to the reflected light, not the glossy hair.

If, now, instead of using this glass negative as a matrix from which to obtain a number of copies, we only care to have one picture, all that is necessary is to blacken up the back. The black shows through the transparent portions, and the other portion, which is metallic to a great extent, appears white by *reflected* light. This is a glass positive. They are often met with as cheap photographs. The small portraits now so largely executed for sixpence and a shilling, are done in this manner. There is a slight but not a great difference in the details of manipulation of the two processes. In the former case, when we wished to produce a negative, the deposition of silver is made as opaque as possible by the aid of organic matter; whereas in the latter case it is required to be as metallic and bright as possible, as you will easily see; but this metallic deposit would not be opaque enough to produce a good positive by printing through; the light would pass through the dark parts, and what should be the light parts would become more or less dark. In fact, a good positive is a bad negative, and *vice versâ.* I may mention that a daguerreotype is of the same class as the positive on glass: one picture of the object is produced by an exposure of the metal plate in the camera, and it cannot be multiplied. Hence the disadvantage of this process.

There are other processes, such as the Calotype, or Talbotype, so called from the inventor, Mr. Talbot. These are of the same class as negatives on glass; but the negative is taken on paper and the paper is then made transparent by waxing, and then printed through. To Mr. Talbot is, I believe, due the idea of taking negatives, that is, taking a photograph which may act as a matrix from which to obtain any number of impressions.

In taking a photograph, then, there are two actions: one, the action of light, the other a chemical action. We take advantage of natural laws and use them for our purpose; and as Bacon, in one of his aphorisms, says: "The knowledge and power of man are coincident; for, while ignorant of causes, he can produce no effects."

On this principle we will examine these two causes and effects; and first the laws of light, though necessarily only in a very cursory manner, and only those points with which we are more particularly concerned.

It is not necessary for me to enter into a discussion of the Newtonian or corpuscular theory of light, according to which light consists of a series of indefinitely minute particles of matter emitted from a body; and of its rival, the undulatory theory. But, as the latter is almost universally adopted, we may consider it true, and certainly sufficient for our purpose.

The evolution, or production of light on the undulatory theory, is considered to be due to the production of oscillations or vibrations in the particles of an elastic ether which pervades space, filling the interstices between the particles of matter, and extending beyond the confines of our atmosphere into infinite space.

The term ether, or luminiferous ether, is applied to an extremely light, if not imponderable, substance, supposed to pervade space. It has never been separated, or obtained, or weighed; but we suppose it to exist because on the supposition of its existence we are enabled to explain almost all, if not all, of the phenomena of light.

This luminiferous ether plays the same part with reference to light, that the air does with respect to sound. The object which gives light affects the medium of ether which surrounds it, creating undulations or pulsations which are transmitted in every direction, in the same manner that the vibrating chord of a harp creates undulations or pulsations in the air which are transmitted in every direction.

The undulations of the ether strike the eye, and we see the object.

The undulations of the air strike the ear, and we hear the sound of the harp. But there is this difference. The luminiferous ether never has been weighed, still it may be, and most probably is, ponderable.

Light, then, is the agitation of this ether so as to produce a vibration, or oscillation, of the particles or molecules with a certain velocity, and in a certain manner, and the agitation of the ether produces waves, or undulations, by which the light is transmitted.

The vibration of the particles, or molecules, of ether is transversal, that is, at right angles to the direction in which the ray is travelling.

Perhaps the simplest, though not perfectly correct, illustration, is that of the waves produced in water when the water is agitated by a stone being dropped into it. A series of undulations travel over the surface in all directions. These undulations are caused by the particles of water moving rapidly up and down perpendicularly to the surface of the water. As each particle is successively put in motion, the successive particles at any one instant are in a different portion of their vibration. At one point just on the horizontal line of the surface of the water; at another, at the highest vertical rise above this line ; at another, at the lowest fall below it; the intermediate particles being in intermediate positions. The line joining these points is a wavy line, as in fig. 3.

All the particles are vibrating up and down. If we take any one particle a: it rises with a decreasing velocity till it reaches the highest point a', then begins to fall with increasing velocity till it gets to the horizontal line xy, then descends with a decreasing velocity to the lowest point a''. Take the instant when this particle is at the highest point a', the different particles along the line, having been successively put in motion, will be at intermediate points in their vibration, and the line joining them will be a wavy line, as shown. In the same manner with light, if we consider this line xy as the direction of a single ray of

light. For though the velocity with which the undulations move along is immensely greater, yet the velocity is measurable. The ether being agitated at one point, each molecule sets in motion the molecules near to it, and the motion is communicated along a line of molecules with amazing velocity.

But the vibration of the molecules is not, as in the water, only up and down, but in every direction, at right angles to the line of direction of the ray ; that is, in a ray of common light.

When we say a ray of light, which comes from the sun, for instance, strikes an object, it is, in reality, the sun causing an agitation in the ether in and about this object; that agitation having been transmitted by undulations in the ether in the intermediate space. And the effect of light on a body is, perhaps, the result of the agitation of the ether between the particles of the body.

When the body struck by a ray of light is transparent, the undulations are propagated through it; and when opaque they are either absorbed or reflected by it.

But, in passing through the transparent substance, such as glass, for instance, light does not, if it strikes the glass at an angle, proceed in the same line in which it was passing through the air. It is a law of optics, that so long as a ray of light is traversing a uniform medium, it continues its path in a straight line; but immediately it enters a denser medium, unless it be incident in a direction perpendicular to the surface, it will be bent or *refracted* out of its original course.

This bending is not the same for all substances. As a general rule, the greater the specific gravity of a body, the more it refracts light passing through it.

Now, if we admit a pencil of white light from the sun into a room, we shall have a small image of the sun on a screen placed to receive it, as shown in fig. 4 by dotted lines, in the same manner that I showed you before that we had the picture of a man in the street.

If we place a prism of glass so as to intercept the rays of this pencil, we shall bend them out of their original direction; but instead of their forming an image of the sun higher up, we find that the rays are dispersed, and an elongated stripe of colour is formed: in fact a pencil of white light is not homogeneous, but consists of various coloured rays.

The violet-coloured rays are most bent, and appear highest up, as shown.

The red are the least bent, and appear lowest down.

Now these different colours are produced by different degrees of undulatory movement in the ethereal medium, in the same manner that different notes are produced by the vibrations of the air being faster or slower.

I have before spoken of the waves of light ; it must be understood that they are very small; thus, the length of a luminous wave of red ray has been calculated to be 0·0000266 of an inch, or 37,640 in an inch, making 458 millions of millions of undulations in a second; while that of violet ray is 0·0000167 of an inch, or 59,750 in an inch, making 727 millions of millions of undulations in a second.

We see that the red ray is caused by the ethereal medium performng, in a given time, about half as many oscillations as are necessary to roduce the violet light of the extreme violet ray ; while the waves in

this latter case are only nearly half as long as in the former, that is, in producing red light.

Now, when we place a photographic substance, as sensitive paper, under the influence of these rays, we find that it is not equally affected by all.

These different rays have different properties, or at least there are three different properties unequally distributed in different portions of the spectrum. You can readily see that the really most luminous portion is about the yellow rays.

If a thermometer be moved about along this spectrum, the greatest heat will be found about the red portion, while the photographic action, the darkening effect on sensitized paper, is found principally about the violet and blue rays. These rays are generally called the actinic rays: no ray, however, can be specifically termed the most actinic. It depends greatly on the substance employed as to which ray is the most actinic.

For instance, when bromide of silver is employed, the actinic action of the spectrum extends from violet to between green and yellow. When iodide of silver is employed, the action only appears to extend a little below the indigo, and it is nearly insensible to the green rays. Hence it has been suggested to employ bromide of silver for landscapes when there is a great deal of green.

I have digressed thus far into the optical laws of the dispersion of the rays of a pencil of white light by a prism, not because they are curious and interesting, but because they directly bear on the machinery we employ in taking a photograph.

A lens, such as I showed you was employed to concentrate the rays of light, may be considered to be a series of prisms.

Two rays of white light coming from an object, fig. 5, would not be concentrated in one point. The violet rays would come to a focus at one point, *v*, the yellow at another, *y*.

When we focussed our glass by the yellow rays, which we should naturally do as they are the most luminous, our objects in the photograph would be undefined, for the violet râys, having been brought to a focus at a point in advance, would have crossed and separated.

There are two ways of overcoming this; either, after having focussed, we might move our sensitive substance nearer in, or, what is better, we may combine the rays.

Different descriptions of glass have different dispersive powers. The dispersive power of flint glass is greater than the dispersive power of crown glass.

If we combine the two, then, as shown by the dotted line in fig. 5, we have a compound lens capable of refracting white light to a colourless focus. The rays are bent outwards by the half-concave, or plano-concave, but more inwards by the convex. But while they are less bent outwards, or made *divergent* by the flint concave lens, they are as much *dispersed* by it as by the crown convex lens, and in the opposite direction. The different coloured rays, therefore, overlap, and as rays of white light, by the greater converging power of the convex lens, are brought to a focus.

We can then combine, by means of a compound glass, two sets of rays together.

I have just stated which rays are the most actinic—the violet; we know which are the most luminous—the yellow. We must therefore

arrange our glasses to combine these two, that is, make them achromatic with respect to the violet and the yellow rays.

Then, when we *see* the object focussed on the screen, we know that the actinic rays also are focussed.

Thus far I have only been considering rays of light as coming from the sun, or other self-luminous body. I must, before quitting this portion of the subject, say a few words on the manner in which rays enter the camera, or how, in fact, we see different coloured objects.

If we let rays pass through coloured glass—take a piece of blue glass, for instance—the object on which the rays fall looks blue; or, if we look through the glass, the objects we look at appear blue, as in using blue spectacles.

This is caused by the substance with which the glass is coloured stopping a certain number of the rays, or checking all the undulations except those which produce a particular colour. Then the transmitted undulations, which are the only ones which reach the eye, give it the sensation of that peculiar colour which is produced by the undulations of white light, minus those which have been checked.

Thus, with smalt-blue glass, the undulations producing red, and some slight portion of those producing blue, are checked; and the transmitted rays of a blue colour will consist of all those undulations which have not been checked.

This property is extremely useful to the photographer; it would be impossible for him to prepare his sensitive substances in ordinary light; for the substances would certainly not know when they ought to be acted on and when not. I before said, however, that the yellow ray has little or no action. The photographer uses yellow glass for his window, or as a shade for his lamp; yellow rays only fall on his chemicals: these have no action, but they give him plenty of *light* to work by.

When the rays of white light from any self-luminous body, such as the sun, or a lighted candle, fall on a body, if the surface of that body be very smooth, the undulations will, after impinging, be reflected (that is, the greatest proportion of them), as in the case of a miror: as the surface becomes rougher, there are fewer undulations reflected, as with this black board, for instance; still there are some rays of white light reflected from all substances.

Again, we find that opaque bodies absorb some of the rays of white light incident on them, and only throw off some; or they excite a fresh set of undulations, and consequently rays of a particular description. Hence they appear of different colours. From a yellow body on which white light is falling, rays of yellow light emanate, or it produces undulations which communicate to the eye the sensation of yellow light. When the surface of the body is such that all the luminous undulations are checked, we call it black.

But still from the surface of all bodies rays of white light are reflected, more or less, according to the nature of the surface. Thus, black silk reflects a great deal of white light, as we see in photographs, by the folds of a lady's dress being well given by portions having bright lights on them; if it were not for this, the whole would be a black mass; and, indeed, the effect would be the same with yellow and red objects.

We only represent these, the yellow, red, and black objects by the

reflection from their surfaces of white light; and are therefore, with the present photographic processes, very far from reproducing colour.

I must now pass on briefly to touch on the chemistry of the subject; that is, to examine the chemical changes in the composition of the bodies we employ in photography, produced or assisted by the action of light; or at least by a property of some of the undulations of the ethereal medium which produced some of the colours which enter into the production of white light. I before showed whereabout in the spectrum the actinic rays lay.

These rays have a very powerful action in producing certain chemical combinations. For those of my audience who may not be very familiar with chemistry, I must explain that chemical combination is a very different thing from mere mixture.

Thus, oxygen and nitrogen, two gases, when mixed, form the air we breathe; when they are combined chemically in certain proportions they form nitric acid, or aquafortis;—certainly two very different bodies: the one, gaseous, supporting respiration; the other, the chemical combination, an acrid liquid, very corrosive, discolouring and burning the skin. I am perhaps hardly quite correct in saying that the combination of nitrogen and oxygen is a liquid; it is really, in its anhydrous state, a solid; but it is very difficult to obtain it in this state; and in its combination with water, that is, as nitric acid, it is liquid.

Nitric acid can be decomposed again into its constituents nitrogen and oxygen, but we are unable to decompose either the nitrogen or the oxygen; hence these are termed elementary bodies, of which there are not a very great number, 63 or 64; and some of these are rarely found, so that, in reality, it is from the combination of a very few bodies, in *different* proportions, that all the various substances in nature are formed. For, as I said before, it is only by the combination of oxygen and nitrogen in certain definite proportions that nitric acid is formed.

We find that it is in the proportion of 14 by weight of nitrogen to 40 by weight of oxygen.

When they combine in the proportion of 14 by weight of nitrogen to 8 by weight of oxygen, we obtain a very different substance—a gas, which may be inhaled, and which, from its peculiar intoxicating properties, is termed laughing gas.

If I write this upon the black board, you will see that there is a curious relation between these two proportions.

Nitrogen.	Oxygen.
14 - - - - - - - -	8
14 - - - - - - - -	40

Five times as much oxygen in the latter case as in the former to the same quantity of nitrogen. There are intermediate stages as it were:—

Nitrogen.	Oxygen.
14 - - - - - -	16—24—32

But no smaller proportion of oxygen or nitrogen than 14 by weight of one to 8 by weight of the other, ever combine.

We may represent these combinations thus:—

$$N_1O_1 \; NO_2 \; NO_3 \; NO_4 \; NO_5$$

The 14 and 8 are termed the combining proportion, or chemical equivalents, of nitrogen and oxygen, because not only do nitrogen and oxygen, where they combine, always do so in these proportions, or in a simple multiple of them, as I have shown above, but because the following law is found to exist in any other combinations. If we take the quantity by weight of chlorine, which 8 by weight of oxygen will combine with, we find it is 35·5.

Again, if we take the quantity by weight of silver, that 8 by weight of oxygen will combine with, we find it is 108.

Then, when chlorine and silver combine, it is in the proportion of 35·5 of chlorine to 108 of silver. Thus it is with all the substances: they always combine in the same certain fixed proportions, or in simple multiples of them.

The different chemical elements combine together with very different degrees of readiness, or, as it is generally termed, some have much greater chemical affinity than others; the result of this is, that when different combinations are brought together, we very often have an interchange of the elements, decomposition and recombination taking place.

I have here a solution of nitrate of silver, that is, a combination of nitric acid and oxide of silver. In this, a solution of common salt—chloride of sodium.

When I mix them you see there is a white curdy precipitate formed.

The action is easiest shown thus:—

$$AgO, NO_5 + NaCl = AgCl + NaO, NO_5$$

The chloride of silver, $AgCl$, being insoluble, shows as a white precipitate.

These combinations, or the tendency of bodies to combine, is much affected by circumstances; for instance, heat will often make bodies combine with violence which might be kept together at ordinary temperatures for a long time without combination taking place. A piece of wood may be kept in the air for any length of time; but if we heat it, it combines with the oxygen of the air with considerable energy, and burns.

Heat, I said, was found in the portion of the spectrum about the red rays. The actinic action of the violet rays is of the same description; it causes some bodies to combine together; it increases their affinities. On some bodies the action is so great that it causes them to combine violently, or explode.

Hydrogen and chlorine are affected in this way. They may be kept together in the dark for any length of time. Under the influence of bright sunlight they will explode. In ordinary diffused light they combine together gradually, and produce hydrochloric acid. But even if the chlorine be carefully isolated and exposed to the sun's rays, it will afterwards combine with hydrogen in the dark.

I have here a flask containing hydrogen and chlorine.

As we cannot get a ray of bright sunlight, I hope the bright light produced by the combustion of phosphorus in oxygen may be sufficient to produce combination.*

* The experiment was tried, but the light, though intensely bright, was not sufficiently actinic to cause an explosion. The light produced by binoxide of nitrogen and bisulphide of carbon was then tried, and was quite successful; showing that, though much brighter, the light of the former was not so actinic as the pale blue flame of the latter.

You see how enormously the affinity of the chlorine for the hydrogen was increased, under the influence of light—sufficiently to produce a loud explosion.

Chlorine is not the only substance affected. Bromine, and iodine, and oxygen have their affinities for hydrogen and carbon greatly increased.

It is on this that the photographic action of light depends; for it is this which causes the decompositions to take place, by giving one of the constituents of the substance acted on, a stronger affinity for some other element present—so strong an affinity that it is drawn away from the body with which it is in combination. We know that the combinations of bodies in different proportions are very different in appearance, and that the appearance of the compound is very different generally from that of its components. Hence, when we withdraw one of the constituents wholly or partially, we alter the appearance of that portion, that is, in the photograph, of the portion on which the light acted.

Here, in this jar, I have this white substance, chloride of silver, a combination of chlorine and silver. The metal silver is rather unstable in its combinations. From what we have seen of the action of chlorine under the influence of light, one can imagine what the effect of exposing this substance to light would be. The chlorine would readily combine with any hydrogen that might be present. And such is the case. If I expose dry chloride of silver to the action of light, there is no effect; but if I have moisture (water) present, the chlorine leaves the silver and combines with the hydrogen of the water to form hydrochloric acid. The white chloride of silver is decomposed; and we have a greyish substance, the finely divided metallic silver.

We also have the result of the action in not quite so advanced a stage, that is, the chloride of silver not reduced to metallic silver, but only reduced to the state of subchloride. The subchloride of silver, which consists of two equivalents of silver to one of chlorine, being violet coloured. $AgCl + HO$ under the influence of light becomes $Ag + HCl + O$. Or the violet subchloride thus: $2\ AgCl + HO = Ag_2Cl + HCl + O$.

If, now, we have some free nitrate of silver present, that is, if all the nitrate of silver be not decomposed by the chloride of sodium, the chain of changes can take place easier, and the darkening of the chloride is faster, for the hydrochloric acid which is formed finds something to go to, as it were; the disruption is rendered easier by its affinity for the silver in the free nitrate, which is thus decomposed; fresh chloride of silver is formed, decomposed, and so on, the action being continuous. $2\ AgCl + HO + AgO\ NO_5 = Ag_2Cl + HCl + AgO, NO_5$; but $HCl + AgO, NO_5 = AgCl + AgNO_5 + HO$; and the $AgCl$ being decomposed, the action recommences.

We have now got the principles of the composition and action of photographic printing papers, that is, the paper on which the negatives are printed—these positives,* in fact—except that the nature of paper itself assists the action. Cotton and linen fibre, of which the paper is made, have an affinity for oxide of silver, and will, under the influence of light, decompose nitrate of silver, and, setting free the nitric acid, combine with

* The various photographs which were shown.

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Again, if we take the quantity by weight of silver, that 8 by weight of oxygen will combine with, we find it is 108.

Then, when chlorine and silver combine, it is in the proportion of 35·5 of chlorine to 108 of silver. Thus it is with all the substances: they always combine in the same certain fixed proportions, or in simple multiples of them.

The different chemical elements combine together with very different degrees of readiness, or, as it is generally termed, some have much greater chemical affinity than others; the result of this is, that when different combinations are brought together, we very often have an interchange of the elements, decomposition and recombination taking place.

I have here a solution of nitrate of silver, that is, a combination of nitric acid and oxide of silver. In this, a solution of common salt—chloride of sodium.

When I mix them you see there is a white curdy precipitate formed.

The action is easiest shown thus:—

$$AgO, NO_5 + NaCl = AgCl + NaO, NO_5$$

The chloride of silver, AgCl, being insoluble, shows as a white precipitate.

These combinations, or the tendency of bodies to combine, is much affected by circumstances; for instance, heat will often make bodies combine with violence which might be kept together at ordinary temperatures for a long time without combination taking place. A piece of wood may be kept in the air for any length of time; but if we heat it, it combines with the oxygen of the air with considerable energy, and burns.

Heat, I said, was found in the portion of the spectrum about the red rays. The actinic action of the violet rays is of the same description; it causes some bodies to combine together; it increases their affinities. On some bodies the action is so great that it causes them to combine violently, or explode.

Hydrogen and chlorine are affected in this way. They may be kept together in the dark for any length of time. Under the influence of bright sunlight they will explode. In ordinary diffused light they combine together gradually, and produce hydrochloric acid. But even if the chlorine be carefully isolated and exposed to the sun's rays, it will afterwards combine with hydrogen in the dark.

I have here a flask containing hydrogen and chlorine.

As we cannot get a ray of bright sunlight, I hope the bright light produced by the combustion of phosphorus in oxygen may be sufficient to produce combination.*

* The experiment was tried, but the light, though intensely bright, was not sufficiently actinic to cause an explosion. The light produced by binoxide of nitrogen and bisulphide of carbon was then tried, and was quite successful; showing that, though much brighter, the light of the former was not so actinic as the pale blue flame of the latter.

You see how enormously the affinity of the chlorine for the hydrogen was increased, under the influence of light—sufficiently to produce a loud explosion.

Chlorine is not the only substance affected. Bromine, and iodine, and oxygen have their affinities for hydrogen and carbon greatly increased.

It is on this that the photographic action of light depends; for it is this which causes the decompositions to take place, by giving one of the constituents of the substance acted on, a stronger affinity for some other element present—so strong an affinity that it is drawn away from the body with which it is in combination. We know that the combinations of bodies in different proportions are very different in appearance, and that the appearance of the compound is very different generally from that of its components. Hence, when we withdraw one of the constituents wholly or partially, we alter the appearance of that portion, that is, in the photograph, of the portion on which the light acted.

Here, in this jar, I have this white substance, chloride of silver, a combination of chlorine and silver. The metal silver is rather unstable in its combinations. From what we have seen of the action of chlorine under the influence of light, one can imagine what the effect of exposing this substance to light would be. The chlorine would readily combine with any hydrogen that might be present. And such is the case. If I expose dry chloride of silver to the action of light, there is no effect; but if I have moisture (water) present, the chlorine leaves the silver and combines with the hydrogen of the water to form hydrochloric acid. The white chloride of silver is decomposed; and we have a greyish substance, the finely divided metallic silver.

We also have the result of the action in not quite so advanced a stage, that is, the chloride of silver not reduced to metallic silver, but only reduced to the state of subchloride. The subchloride of silver, which consists of two equivalents of silver to one of chlorine, being violet coloured. $AgCl+HO$ under the influence of light becomes $Ag+HCl+O$. Or the violet subchloride thus: $2\ AgCl+HO=Ag_2Cl+HCl+O$.

If, now, we have some free nitrate of silver present, that is, if all the nitrate of silver be not decomposed by the chloride of sodium, the chain of changes can take place easier, and the darkening of the chloride is faster, for the hydrochloric acid which is formed finds something to go to, as it were; the disruption is rendered easier by its affinity for the silver in the free nitrate, which is thus decomposed; fresh chloride of silver is formed, decomposed, and so on, the action being continuous. $2\ AgCl+HO+AgO\ NO_5=Ag_2Cl+HCl+AgO,\ NO_5$; but $HCl+AgO,\ NO_5=AgCl+AgNO_6+HO$; and the AgCl being decomposed, the action recommences.

We have now got the principles of the composition and action of photographic printing papers, that is, the paper on which the negatives are printed—these positives,* in fact—except that the nature of paper itself assists the action. Cotton and linen fibre, of which the paper is made, have an affinity for oxide of silver, and will, under the influence of light, decompose nitrate of silver, and, setting free the nitric acid, combine with

* The various photographs which were shown.

the oxide to form a warm brown substance which gives a fine tint to the photographs.

In the sizing of the paper there are organic substances, and in most prints albumen; the white-of-egg being employed to give the paper an even surface to bring out the minor details well. These form organic subsalts of silver, which are of a reddish colour.

We have now the requisites for printing the positive we have taken. I am rather putting the cart before the horse; but this process leads to the other, as it is the simplest and easiest explained.

The paper is first prepared with chloride of sodium (common salt), or chloride of barium, or chloride of ammonium;* it is then treated with nitrate of silver solution which, being partially decomposed by the chloride, forms chloride of silver with free nitrate, as was the case in this glass jar.

The paper now contains moisture, chloride of silver, nitrate of silver, vegetable fibre (the fibre of the paper), and the sizing, which consists of starch or gelatine.

You will understand from what I have said how the image is formed: the chloride in the presence of moisture is decomposed by light, and gives a feeble violet image, which is strengthened by the nitrate assisting the action; and this again becomes more vigorous, with a redder and warmer tone, bythe decomposition of the nitrate, and combination of the oxide, first with the size, and secondly with the fibre of the paper.

We have then to fix the image, which is effected by removing the unchanged or unaffected chemicals, so that on its exposure to light the image may not be lost by the whole photograph becoming equally dark.† Hyposulphite of soda will effect this by forming a soluble double salt, hyposulphite of silver and soda, and chloride of sodium; in this way, the hyposulphite of soda is decomposed by chloride of silver, forming hyposulphite of silver and chloride of sodium; and the hyposulphite of silver is soluble in a large quantity of hyposulphite of soda.‡ That the hyposulphite of silver is only soluble in excess of hyposulphite of soda, must be borne in mind, for after a bath of hypo has been used for some time it becomes saturated,§ and will no longer fix prints, as it can hold no more silver in solution, but, decomposing, forms yellow spots and patches, which gradually blacken.

Of Developing.

Thus far we have only obtained a slowly-working process, the common sun-printing, in which the image is *gradually produced* under the *continued action* of light.

If it were necessary to expose the plate for an hour or so while a photograph was being slowly taken by a continuous change, it would be

* $NaCl + AgO,NO_5 = AgCl + NaO,NO_5$
$BaCl + AgO,NO_5 = AgCl + BaO,NO_5$
$NH_4Cl + AgO,NO_5 = AgCl + NH_4O,NO_5$.

† $NaO, S_2 O_2$.

‡ $Ag Cl + 3NaO,S_2O_2 + M$ Hypo$=2NaO, S_2O_2$. $AgO, S_2O_2 + Na Cl + M$ Hypo. M representing an indefinite quantity.

§ $AgO S_2 O_2 = AgS + SO_2$ the sulphuret of silver being formed.

difficult to take landscapes, while portraits would be out of the question. We therefore resort to what are termed development processes. In these a change in the chemicals is induced by an exposure of a few minutes or seconds, or sometimes of half or quarter of a second, depending on the amount of light, and the description of lens employed.

We are now considering the process for taking negatives which are on glass. In order to hold the sensitive substances on the glass, the glass is coated with collodion, that is, a solution of gun cotton or pyroxyline in a mixture of ether and alcohol. As this substance only plays a passive part, holding the sensitive salt of silver in a finely divided state on the surface of the glass, it is unnecessary to enter into its chemical composition.

In the collodion process, after having exposed the plate, on taking it into the dark room, we find no visible change on any part; a change has been impressed by the action of light, but it may be only a molecular change. This change is continued by the action of the developer, that is, a liquid is poured over the plate and gradually blackens those portions on which the light has acted. The image appears and becomes more and more intense as the development proceeds.

The developer is a compound liquid, the components of which, by their chemical reaction, are gradually decomposing one another, and depositing a darkening substance, which, in consequence of the attraction of cohesion, falls only on those parts that have been changed or modified by the action of light. The developer also, in some cases, continues or assists the change which has been commenced in the sensitive film, and then deposits the silver on the altered parts.

There is a radical difference between the chemistry of sun-printing and that of the development processes. In the sun-printing, light was gradually causing certain bodies to decompose, and reunite to form new compounds; in the development processes, light almost immediately impresses an image, and the developer merely throws down dark matter on that image. Thus, if you touch a dry plate of glass with your finger and then breathe on it, the breath acts as a developer, for it will bring out the markings which were invisible before, by depositing only on the other parts. And again, a photograph which has been partially developed, may be fixed, washed, and dried, and kept any length of time, and the development again proceeded with by a fresh application of the developer; for the silver, while being precipitated from it, will fall only on that already formed. Light has the same power of so modifying the surface of bodies that vapours are precipitated differently on the parts which have been under its influence from those which have not. If a plate of mirror-glass be exposed in the camera and then breathed upon, the breath, by settling more strongly on the parts affected by the light, will develope an image. This image, which is invisible till developed, is commonly called the latent image.

You will understand from this, how the sensitive surface of iodide of silver, when exposed in the camera, has parts of its surface modified by the light, and a change, perhaps only a molecular change, but sufficient to develope upon, induced in the chemicals, though no visible image has appeared.

The action of the developer is seen if we mix protosulphate of iron and nitrate of silver ; the nitrate of silver is decomposed, in consequence of the strong affinity of the protosulphate of iron for oxygen, which then becomes persulphate, precipitating silver and setting nitric acid free.* And again, nitrate of silver is decomposed by pyrogallic acid, which, being a powerful deoxydizer, or absorber of oxygen, precipitates silver by depriving it of its oxygen.

The nitrate of silver would undergo a general decomposition, and blacken the whole plate if there were nothing present to check the action of the developer, and retard the decomposition of the nitrate of silver. An organic acid, such as citric or acetic, is therefore added to render the precipitation of silver more gradual.

Now, the particles of silver, which in a very finely-divided state are being precipitated, from their cohesive attraction for one another have a great tendency to unite together while they are floating about in the developer, and to accumulate on any particles already formed on the plate. And as the salts of silver in the sensitive film, if they have not been already reduced to the metallic state where acted on by the light, have been modified by it, and a change induced, these points act as centres of attraction for the falling particles, which, uniting together, fall on them and continue accumulating as long as there is nitrate of silver in the developer to be decomposed and supply fresh silver.

But to return to the salt of silver employed in this case for the sensitive film, it is not the chloride of silver that we employed for the paper, but the iodide or bromide of silver. Iodine and bromine, as I mentioned, were affected in the same manner as chlorine by light, that is, in having their affinities for hydrogen increased, though not to the same extent as chlorine. And it appears curious at first why, when we want a more sensitive substance, we employ one which is less affected by light.

The theory is rather complicated, and not very certain, but it is probably this:—

Pure moist iodide of silver is not affected by light, for the chemical affinity for hydrogen induced in iodine by light, is not so great as that induced in chlorine. Thus, iodine will not liberate oxygen from water in the light; chlorine will, forming hydrochloric acid with the hydrogen;† whereas hydriodic acid (iodine and hydrogen) is decomposed on exposure to the air by the oxygen of the air taking the hydrogen, to form water.‡

But though iodine has not sufficient power to *displace* hydrogen, if the brown solution of iodine in water§ be exposed to the light, the tendency is so far increased, that the solution becomes colourless, by the iodine combining with both elements of the water to form iodic acid with the oxygen, and hydriodic acid with the hydrogen of the water, which in the *dark* decompose one another, reforming water and iodine. Hence, though the

* $AgO,NO_5 + FeO,SO_3 = Ag + NO_5 + Fe_2SO_3$.

† $HO + Cl = HCl + O$.

‡ $HI + O = I + HO$

§ $5HO + 6I = IO_5 + 5HI$.

tendency given by light to iodine to combine with hydrogen, is not sufficient to cause iodide of silver to be decomposed in the presence of water alone, and form iodic and hydriodic acids; if there be free nitrate of silver present, the silver from which can take the iodic and hydriodic acids, to form iodate and iodide of silver, then the change is rendered much easier, and the light can affect it.* Especially if we suppose, as is most probable, that the iodide is reduced only to the subiodide.

In the dark, without organic matter, iodide and nitrate of silver are reformed. But if there be any organic matter in the collodion which has a tendency to absorb oxygen, and combine with the subsalt, the change is rendered more complete.†

The developer, having a tendency to absorb oxygen, would act in the same way. Thus, when iodide of silver is employed, light causes merely a rearrangement of the elements, which it has just sufficient power to prevent returning to their former state; whereas, when chloride is employed, the release of one of the elements is effected. But the change, being less complete, is more easily impressed. And this change having been impressed, is sufficient to develope upon. The particles of silver which are being precipitated from the developer falling, as I before explained, on the places where the change to subiodide, though not perceptible to the eye, is commenced.

To impress this change sufficiently to develope a *good negative* upon, a certain definite length of time of exposure is necessary, varying according to the intensity of light in the camera, though a slight amount of under exposure may be compensated for by more development, and over exposure by less; yet this latitude does not extend beyond very short limits, and no amount of development will compensate for *under* exposure, as then the feeble lights not having had time to impress themselves, the photograph is deficient in half tones; and in *over* exposure, not only do the feeble lights, by acting too long, impress themselves too strongly, and, overtaking the high lights, appear as such; but the high lights themselves go back as it were, and do not leave a sufficient change to develop on. For it must be remembered that I am speaking of negatives; and where the greatest amount of silver forms, the least light will be able to pass through; and acting very slightly, or not at all, will there leave the print lightest.

The manner in which we obtain the collodion film charged with iodide of silver is something like the way in which we sensitized or charged the paper with chloride of silver.

The collodion is mixed with iodide or bromide of potassium, of cadmium, or of ammonium, or a mixture of these. The glass plate is then coated with it; when nearly dry the plate is put into a bath of nitrate of silver. A double decomposition then takes place similar to the one with chloride of sodium and nitrate of silver, and iodide of silver is formed in the film.

After the negative has been sufficiently developed, it is fixed by removing the unchanged iodide with hyposulphite of soda, or, as is generally done,

* The following is a probable explanation,—$6Ag,I + 6AgO,NO = AgO,IO + 5Ag,I + 6\,NO_5 + 6Ag$; or more probably$= AgO,IO_5 + 5Ag_2I + 6NO_5 (+ Ag)$.

† $AgI + AgO,NO_5 + M = Ag_2\,I + NO_5 + MO$. But rendering the change more omplete, makes it more difficult to accomplish, and therefore gives a less sensitive film.

by using cyanide of potassium, which is a more rapid solvent, but acts in tho same way, that is, forms a soluble double salt of cyanide of silver and potassium.

We must, however, leave this portion of our subject. I have already kept you too long.

With respect to the application of photography to military purposes, the first necessary is portability in our apparatus. Captain Fowke, of the Royal Engineers, who has fitted out most of the parties of Engineers who have taken photographic apparatuses with them, invented this form* of camera, which is extremely portable, collapsing into this size. It can be easily carried in knapsack.

With this camera and chemicals, &c., carried in boxes on pack-saddles, the different photographs which were exhibited had been taken by parties of Sappers.

1. A series by Corporal Lawson, who formed one of the party with Lieutenants, now Captains, Gordon and James, R.E., on the Asiatic boundary in Asia Minor, between Russia and Turkey.

2. A series by Sergeant Church, who accompanied Colonel Stanton when he went to verify the reports on the projected line of railway across the Isthmus of Panama—the Honduras line.

3. A series which were done in India, and at Singapore.

4. A series in China ; from which Mr. Burford took his panorama.

5. A series by Sergeant Mack, R.E., at Moscow, whither he accompanied Lord Granville.

6. And, lastly, two which were done at Varna. The photographers who came out to the Crimea were unfortunately lost on board the Prince. One of the photographs was a copy of the plan showing the order of landing; Photography having been employed to obtain a number of copies of it.

Hence, we see that photography can be applied under very difficult circumstances, such as on long and rapid journeys, and that, in fact, the photographer could accompany the army in the field; and, what is more, that the art can be learned and practised by our men.

Many of these photographs are certainly not such as Mr. Fenton or Mr. Thurston Thompson would care to exhibit at the Photographic Exhibition. Still, some of them are very good as photographs, all of them, I think, are very creditable when we consider the circumstances under which they were executed.

Photographs of country give a most truthful and accurate idea of it. They would do more to give a correct idea of any particular position than yards of description on foolscap. They might be found of great service in illustrating a report on a country, as, indeed, they have been employed by Colonel Stanton ; and in this way they might be of great service to the general commanding an army in the field.

Photographs are of great service in providing the engineer with a ready and rapid means of making progress-plans, showing the state of the works on any particular day ; in fact, so good and so truthful a way that I believe it was first adopted by the Russian Government, who have often

* Captain Fowke's camera, made by Ottewill, was exhibited.

had considerable difficulties in this direction with their engineers and contractors. For though one may draw the plan and elevation of an imaginary fort or castle in the air, one cannot photograph it.

(Some progress-plans of the works at Aldershot for the War Department were shown.)

Photography can also be employed in copying and multiplying plans; as in the case of this plan of the position of the ships for landing the troops in the Crimea.

I have here a number of photographs executed at Chatham, which show what an admirable means they afford of conveying descriptions of various operations—bridge-making, and so on—taken at various stages of progress, which could only be done by expensive lithographs, and then not so well.

We are enabled to obtain a perfect picture of any size we wish. I could not give a better example than these photographs of the Cartoons at Hampton Court. They are done on five different scales. (The different series were shown.) You will, perhaps, think that they have little to do with the application of photography to military purposes. My reasons for exhibiting them are, that they are admirable specimens of photography, and that they were executed, with the assistance of Sappers of the Royal Engineers, by Mr. Thurston Thompson, who has instructed most of our men at South Kensington.

I have lastly to call your attention to some other applications of photography. They are scarcely for a purely military purpose. They are the reductions of the maps on the Ordnance Survey from one scale to another, for engraving. By employing photography for these reductions, the Survey Office at Southampton saves £1,600 per annum, and the whole saving on the survey will be about £32,000; and this with increased rapidity and accuracy. Formerly the reductions were made by the pentograph, a long and tedious operation, in which, as the hand and eye were employed, the accuracy was dependent to a great extent on the skill of the operator.

Now, by merely fixing the camera at different distances from the plan to be copied, it can be reduced to any scale desired by an operation of a few minutes, and with the greatest accuracy.

The scales of the maps are for—

Towns, $\frac{1}{500}$, or 10·56 feet to 1 mile.
Parishes, $\frac{1}{2500}$, or 25·344 inches to 1 mile.
Counties, 6 inches to 1 mile.
Kingdom, 1 inch to 1 mile.

The 10-inch is reduced to the 25-inch, and the 25-inch to the 6-inch, by photography.

But here the perfect truthfulness of photography militates against it. In reducing from the 6-inch to the 1-inch scale, the photograph is too crowded with details, so that at present in a portion of this operation the pentagraph is still employed.

The photographs are at once transferred to the copper plates for the engraver, or the zinc plate for the zincograph process, in this manner: instead of printing from the negative on to ordinary printing paper, they employ printer's tracing paper, sensitized by being washed over with a

saturated solution of bichromate of potash and gum-water. This prepared paper is exposed to light under the ordinary glass negative, and the portion of bichromate of potash acted on becomes insoluble in water, but without changing colour (this is a peculiar property of bichromate of potash). The print is then covered with the greasy lithographic ink, placed face downwards on a metal plate and passed through a press until it becomes almost black in appearance.

It is then washed with a solution of gum arabic and hot water, and brushed with a camel's hair brush; this removes the portions not acted on by the light, by dissolving the bichromate of potash, and leaves a print of a light brown colour in lithographic ink.

This can be either transferred to the copper plate, as a guide to the engraver, by burnishing ; or it may, in the same way, be transferred to the zinc plate, and printed from immediately, without any further process, by simply being inked with printer's ink.

Friday, January 25th, 1861.

Captain E. PACKE, in the Chair.

THE HISTORY OF THE FORTRESS OF MALTA.

By Major PORTER, R.E.

THE history of the Fortress of Malta is a subject which I consider ought to command the willing attention and interest of the Members of a society so peculiarly professional as is ours. Having been for some years stationed at Malta, I have had, perhaps, more facilities than fall to the lot of persons generally of becoming acquainted with those details by which the fortress has gradually risen from a very small beginning to the position which it now occupies. Whilst there, I had the opportunity of studying the numerous records left by the Knights of St. John when they were expelled from the island. These are to be found, partly in the Royal Engineer Office, at the station, and partly at the Public Record Office; which latter I was enabled to inspect through the kindness of the authorities.

But, before I commence the actual history of the fortress itself, I think it right, with your permission, to give a brief and hurried summary of the antecedent history of that fraternity, half soldier and half monk, under whose auspices, and through whose munificent liberality, the island was raised from the position of a mere barren rock to become one of the finest strongholds of Europe.

The development of Christianity in Europe had brought with it a practice, which ere long became very general,—for the pious to make pilgrimages to the Holy Land; and, as the influx of these visitors produced a considerable revenue to the emperors of the East, that practice was encouraged in every way. When, however, the successors of the impostor Mahomet had, amongst their numerous other acquisitions, brought the province of Judæa under their domination, the position of the pilgrims who still continued to flock thither from Europe became very much deteriorated. It is true, the Mahometans did not altogether prohibit these pilgrimages; they were too keen-sighted and politic for that, and perceived that a large revenue would be received by them, as it had been before by the emperors of Constantinople; still they pillaged and harassed the pilgrims in every possible way.

Under these circumstances, some pious merchants of Amalfi, in Italy, obtained the permission of the Caliph Mustapha Billah to establish a hospital in the city of Jerusalem, for the succour and maintenance of visitors to the Holy City. This hospital was the first germ of the Order of St. John of Jerusalem, which, sprung from that slender stock, was destined to become renowned throughout Europe and the East for its military prowess and power.

We all know how Peter the Hermit, having made a visitation to the East, endeavoured on his return to arouse the religious enthusiasm of Europe for the purpose of rescuing the Holy Land from the grasp of the infidel, and we know how his efforts resulted in the first Crusade, and how Godfrey de Bouillon succeeded in tearing the Holy City and parts of the adjacent country from the Saracens, and in establishing a Christian kingdom.

The Hospital of St. John was at this time presided over by a pious man named Peter Gérard; and under his auspices such of the Crusaders as stood in need of succour were hospitably entertained by the fraternity. Godfrey de Bouillon, to mark his gratitude, endowed the institution with a gift of land; and, his example being followed by many others, the hospital became ere long extremely wealthy.

The successor of Peter Gérard, Raymond du Puy, who had been a knight, and had taken the vows of the Order, attracted by his admiration for the charity and devotion of its members, felt ere long a craving to return to his previous martial life; and, as he could not possibly gratify his longing in any other way, he proposed to the King of Jerusalem that the Order of St. John should become military. Under these circumstances, it was established as a military order; not abandoning its previous vows of poverty, chastity, and humility, it was still a monastic order, but it had added thereto the further obligation of fighting in behalf of religion.

I need not trace their career during the existence of the kingdom of Jerusalem, of which they, in conjunction with the rival fraternity of the Templars, were the main support. After the city fell into the hands of Saladin, the Order was removed to Acre, where they continued their struggle against the Infidel, until, at the close of the thirteenth century, that city was torn from their grasp. It was the last stronghold the Christians retained in the East, and after its fall the Knights of St. John were driven to abandon the Holy Land.

After a short sojourn in Cyprus, they made themselves masters of the island of Rhodes, and proceeded to establish their convent there.

Up to this time their organisation had been entirely military, but now that they were settled in the island of Rhodes they found themselves compelled to change their tactics, and to adopt a maritime career. They fitted out galleys with which to protect the commerce of the East from the depredations of the Infidel corsairs, who swarmed in those seas. The pirates of the Levant were at that time the scourge of the Mediterranean; and, as the order of St. John constituted themselves the police of that sea, they became ere long objects of as much terror and hatred to the Infidel on the water as they had before been on the battle-field.

Accordingly, in 1480, the Sultan Mahomet II. determined to besiege Rhodes and extirpate these troublesome antagonists. That siege ended in the rout of the Infidels, and the army of Mahomet was forced to retire in disgrace and confusion from the island; but in 1522 Solyman, surnamed the Magnificent, who had then lately succeeded Mahomet, again besieged Rhodes, and, after a struggle protracted during six months, expelled the Knights, who were thus once again deprived of their homes, and become wanderers on the face of the earth.

After a lapse of eight years, Charles V., King of Spain and Emperor of

Germany, made an offer of the island of Malta to the homeless Order; and thus it was that this barren rock became an important fortress. The antecedent history of Malta itself may be dismissed in a few words. It had been originally colonised by the Phœnicians, who were expelled by the Greeks after the siege of Troy. Nearly three centuries later the Greeks were expelled by the Carthaginians, and they in their turn gave way to the Romans. The Romans held the island until Theodoric, King of the Ostrogoths, drove them from it. It was subsequently retaken by Belisarius, but soon fell into the hands of the Saracens, when they made their way into that portion of Europe. It was wrested from the Saracens by Count Roger, and attached to Sicily, and with Sicily it remained until after the tragedy of the Sicilian Vespers, when it fell into the possession of Spain, by whom it was transferred to the Order of St. John.

When the knights arrived in their new home they found that the only work of defence in the island was a small fort mounting two guns, and dignified by the appellation of the Castle of St. Angelo. In fact, the only attraction which the island possessed for the knights lay in its magnificent harbour. This harbour is divided in two by a promontory called Mount Sceberras; the larger portion is in its turn subdivided by two tongues of land, thus forming creeks, each of which affords good anchorage. This harbour is called the Grand Port; and the other, which is neither so large nor so commodious, is called the Marsa Muscetto, or quarantine harbour. When the Grand Master, L'Isle Adam, arrived in Malta, his first care was to house his fraternity in a little village on the shore of the Grand Port, called the Bourg, and situated on one of the promontories above mentioned. The revenues of the Order being at that time in a very exhausted condition, the only work of defence he was enabled to undertake was a line of rampart and ditch of very slender profile across the head of the promontory. This was constructed during the first year of the Order's residence in Malta, viz. 1530. In 1541 an Italian engineer, named Caramolino, was called on by the Grand Master, John d'Omedes, to advise as to the best mode of strengthening the island. He considered that the position which had been taken up at the Bourg was a bad one. It was overlooked by a high hill called Mount Salvator, and other portions of the adjacent country, so that, in his opinion, it was impossible to fortify the position sufficiently. He therefore recommended that they should occupy the Mount Sceberras, where he said the convent ought to have been originally fixed. At that time, however, there were no funds to carry out his proposition, and the Knights were compelled to remain in the Bourg, contenting themselves with deepening its ditches, and raising a cavalier in the Castle of St. Angelo, to dominate over the hill which had previously threatened them.

Still, the Order did not feel safe. There were rumours of expeditions on the part of the Turks, and they felt that at any moment they were liable to an attack; they therefore called in a Spaniard, named Don Pedro Pardo, the chief engineer to Charles V. In 1553 this officer designed two forts, one to occupy the extremity of Mount Sceberras, and called Fort St. Elmo; the other the promontory of St. Michael, by which name it was afterwards known, and these works were executed in accordance with his designs.

The succeeding Grand Master, Claude de la Sengle, still feeling dissatisfied with the strength of the position, resolved to surround the entire peninsula of St. Michael with a rampart, and to establish a town within its

enceinte. This town took the name of its founder, and has been ever since called Senglea. Such was the position of the fortress when La Valette, successor of La Sengle, became Grand Master. It was now evident that a siege on the part of the Turks was imminent. A piratical empire, as I may call it, had been established at Algiers by the brothers Barbarossa, Horuc and Hayradin, and their lieutenants Sinan and Dragut, of whom at this period the latter was the sole survivor.

As ruler of the city of Algiers and the adjacent territory, he was tributary to the Sultan, and was prepared to render every assistance in his power to an expedition against his sworn foes the Order of St. John. Solyman the Magnificent, the same sultan who had expelled the fraternity from Rhodes in 1522, was still on the throne, and, irritated at the constant successes of the knights over his own naval armaments, he determined, as the last act of his lengthened and prosperous career, to expel them from their newly-established home, and organised a powerful expedition for the purpose in the arsenals of Constantinople.

This expedition arrived in Malta on the 18th May, 1565, and consisted of 130 vessels, under Admiral Piali; the land force, under Mustapha Pacha, numbering 30,000 men. The army landed partly in St. Thomas's Creek and partly in Marsa Scirocco, at which point they combined and marched on the town.

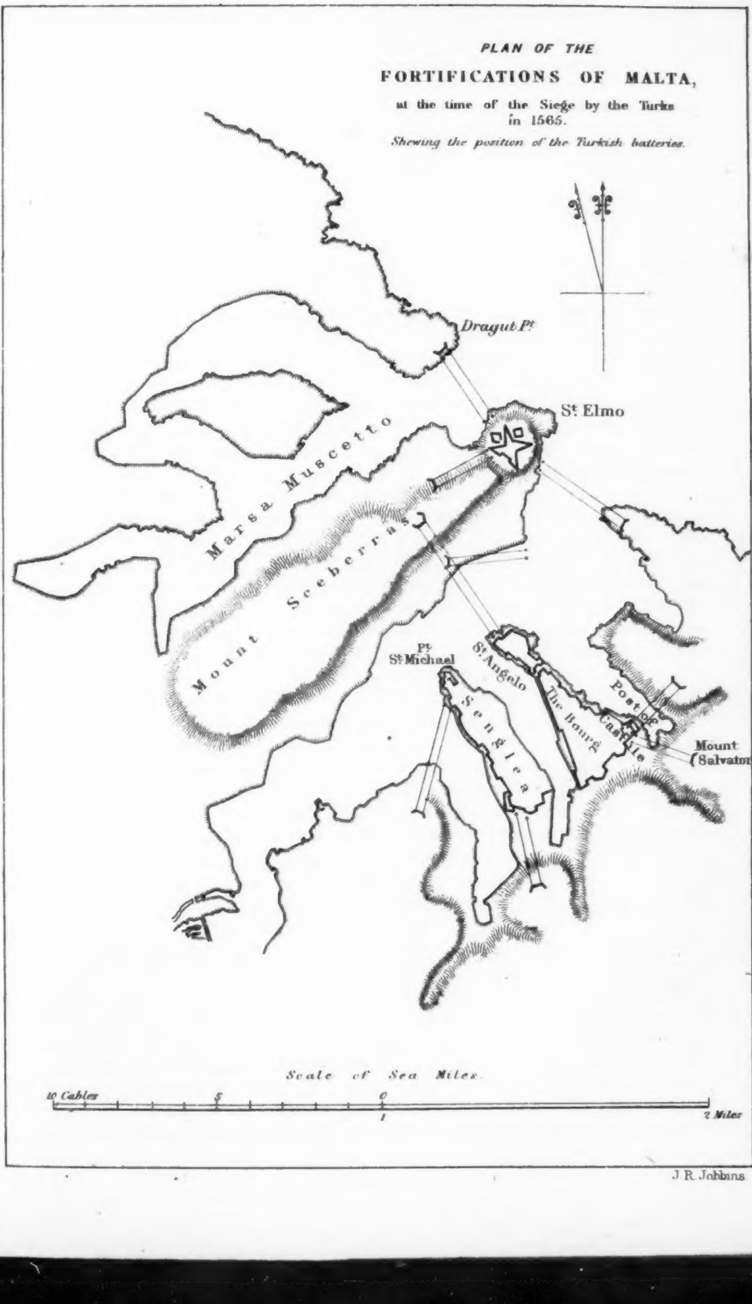
The garrison of the island at this moment consisted of 474 knights, 67 servants-at-arms, and 8,155 men—partly militia of the island, partly regular troops in the pay of the Order (principally Spanish), and partly volunteers from Italy. During the latter portion of the siege a reinforcement of 40 knights and 700 men succeeded in making their way into the place.

Mustapha and Piali had received instructions from the Sultan that they were to pay great deference to the opinions of Dragut, the corsair Dey of Algiers, at that time considered one of the most able generals of the day. Dragut not having arrived, there was a difference of opinion between Mustapha and Piali as to their immediate line of conduct. Piali was for awaiting his advent; but Mustapha, fearing the arrival of succours to the besieged, determined upon at once commencing the siege by attacking the Fort of St. Elmo, the small work already alluded to, which had been erected at the extremity of Mount Sceberras. Its trace was that of a star fort with four salients, but on the land front the star form had been broken into bastions; and on the opposite side arose a cavalier, which dominated over the remainder of the work. The inclosure was very confined, containing but a small garrison, and was most inconvenient for defence. Mustapha therefore determined to attack it at once, believing that in a few days he could effect its capture.

He opened his trenches on Mount Sceberras,* but did not carry them completely across the peninsula, being desirous of screening them from the enfilade fire of Fort St. Angelo. The evil which arose from this mode of attack was, that a free communication could be maintained between the garrison of St. Elmo and their comrades of the Bourg.

Fire was opened from the besiegers' batteries on the 31st May, and in a very short time a practicable breach was effected. The garrison, anxious

* The position of the besieger's batteries at this point and elsewhere throughout the siege is marked on the annexed map, which also shows the extent of the fortress at that time.


PLAN OF THE
FORTIFICATIONS OF MALTA,
at the time of the Siege by the Turks in 1565.
Shewing the position of the Turkish batteries.
Dragut Pt
St Elmo
Marsa Muscetto
Mount Sceberras
Pt St Michael
St Angelo
Senglea
The Bourg
Post of Castile
Mount Salvator
Scale of Sea Miles.
10 Cables
5
0
1
2 Miles
J R Jobbins

to protract the fall of the fort as long as possible, made a sally with the intention of destroying the besiegers' trenches and batteries. At the outset they were successful in their object, driving the foe from their batteries and destroying a considerable portion of the siege works. On the arrival of reinforcements, however, the Turks once more drove them back into the fort, and, under cover of the smoke and confusion, were enabled to establish themselves on the counterscarp of the work.

From this point an incessant cannonade was kept up on the unfortunate garrison, and ere long the fort was in such a state of ruin, that Mustapha decided upon giving the assault on the 15th June. The attack commenced at daybreak and lasted for several hours; the Turks, however, did not succeed in penetrating into the work, and were at length compelled to retire in confusion. Time would fail me were I to attempt to detail the incidents of this assault, or the weapons which were in use for attack and defence. Among other contrivances, the defenders had caused hoops to be wound round with cotton and steeped in inflammable matter, which, when ignited, they hurled into the midst of the Janissaries, setting fire to their flowing robes and thus burning many to death. Another ingenious missile of which they made use, was a shell of earthenware filled with Greek fire; attached to it was a slow match, which was ignited, and the shell thrown into the midst of the assailants. Breaking as it fell, the lighted match ignited the Greek fire, and the flames spread in every direction.

As I have before said, the Turks were repulsed, and the Knights held their own. It was at this point in the siege that Dragut arrived. He objected to the policy of having commenced with the attack of St. Elmo, and also to the mode in which that attack had been hitherto carried on. He at once established a new battery at the northernmost point of the Marsa Muscetto, which since that time has been always known by the name of Point Dragut. On the ridge of Mount Sceberras he also established a second battery, one face for the attack of Fort St. Elmo, and the other to reply to the fire of St. Angelo. After these new batteries had opened their fire, the fort was again assaulted, but the attack proved as fruitless as on the former occasion.

Dragut now perceived that, in order to accomplish the capture, it would be necessary to cut off all communication between the garrison and the Bourg; he therefore extended his trenches entirely across the peninsula, and erected a small battery to command the crossing and landing place. This accomplished, the Turks made a third assault, on the 22nd June, and were for the third time repulsed; but having cut the garrison off from all support, the capture of the fort, in spite of the heroism of its defenders, had now become a mere question of days.

The Knights knew that their last hour was come: decimated in numbers, and cut off from support, further resistance was hopeless, and they felt that on the next day the fort must fall. At midnight they assembled in their little chapel (a small building in what is now the Artillery barrack), and there they all partook of the Holy Sacrament. It was a sad and touching spectacle, that midnight meeting within the ruined chapel. Each one felt that the morrow must bring their doom; though resigned, yet determined, their features lighted up with the hope imparted by the sacred rite of which they had just partaken; standing in little groups round the altar, the dark-

ness scarce dispelled by the few lights which flickered above them, it was one of the most touching scenes of heroism and endurance which history has ever recorded.

The next day the last assault was given, and the fort was taken; there were only sixty defenders alive when the place fell, and these were at once slaughtered by the enraged Turks. It was thus that, after a siege of upwards of five weeks, and on the eve of their patron saint's day, the Fort of St. Elmo was lost. So far the Turks had been successful, but much precious time had been wasted. They now therefore determined to lose not a moment in laying siege to the Bourg and St. Angelo. For this purpose they moved their forces round to the other side of the harbour, and opened their trenches against the defences of Senglea and the Bourg. They fixed upon the Point of St. Michael for their assault, and, in order to carry out that purpose with greater facility, they caused large galleys to be conveyed across the tongue of land between the head of the Marsa Muscetto (which had fallen into their possession after the capture of St. Elmo) and that of the great harbour. Embarking their men in these galleys, they delivered their assault with the utmost desperation; but their efforts were in vain, and they were forced to retire. They then established batteries upon Mount Salvator, to breach the ramparts at the head of the Bourg, and others to breach the Point of St. Michael and the Post of Castile. This latter, so called because it was defended by the Knights of Castile, became from this time the great scene of struggle throughout the remainder of the siege, and for nearly a month the Turks continued assaulting alternately this post and the Point of St. Michael, but always without success.

While the siege was being thus protracted, reinforcements were assembling in Sicily; and after numerous delays, partly caused by the dilatoriness of the viceroy, and partly by adverse winds, they were at length enabled to reach Malta, and effected a landing in Melleha Bay on the 6th September. The Turks, who were greatly dispirited owing to their constant want of success, as soon as they heard of the landing of the relieving force, abandoned their trenches in all haste and took to their ships. The Knights immediately sallied forth, overthrew their batteries, and in a few hours destroyed the labour of many months.

When Mustapha discovered how few in number the reinforcements were, he determined to land his forces again, and once more to renew the siege. Notice was immediately sent by the garrison to the advancing force, that the Turks had relanded, and were proceeding into the interior of the island to oppose them. They therefore entrenched themselves on the heights of Nasciar, a range of hills near Citta Notabile, from whence they could resist the attacks of the advancing Turks. One battalion amongst the reinforcements was composed exclusively of knights; and, when the enemy appeared, these men could not be restrained, but, abandoning their entrenchments, rushed impetuously on the foe. The Turks, who were much dispirited, and had been with difficulty landed from their ships, turned at once, without striking a blow, and fled in confusion back to their fleet, which speedily made sail and returned to Constantinople. Such was the termination of the great siege of Malta of 1565, which has been justly considered one of the most gallant and heroic defences of that century.

It is true that the defence had been successful; but at its close the


PLAN OF THE
FORTIFICATIONS
OF
MALTA
Estima Pt
Dragut Pt
Fort Tigné
St Elmo
(Light F.)
Pratique
VALETTA
Pratique
Ricasoli Pt
Ricasoli
Hospital Pt
Navy Hospital
Calcara
St Angelo
Senglea
Arsenal
Vittoriosa
Burmola
Cotonera
Corradino
Navl Magazn
FLORIANA
Garden
Pieta
Floriana
Hornwork
Scale of Sea Miles
10 Cables
5
0
1
2 Miles

J. R. Jobbins

position of the Order was most critical, their works being in ruins, and their funds exhausted. After much deliberation the Grand Master, La Valette, determined not to abandon the island, and he accordingly invoked the aid of a Spanish engineer named Quinzan de Montalin. It was decided that, as the Bourg had proved to be neither a convenient nor a safe position for their convent, a new town should be established upon Mount Sceberras. This town, which, after the name of its founder, was called Valetta, was erected upon the designs of Laparelli, an Italian engineer in the service of the Pope. A glance at the diagram* will show that the trace of its enceinte was very much the same at that time as it still remains. Being totally deficient in funds, the Order had recourse to the issue of fictitious money, bearing on one side the emblem of two hands clasped, and on the other the motto, "Non æs sed fides," "not money but trust." This coinage was freely accepted by the artificers and labourers; and, as money poured in from the different exchequers of Europe, it was honestly redeemed. La Valette did not live to see his town completed, which was not until 1571, when the convent was removed from the Bourg, and established in its new home with great pomp and solemnity. I may here mention that the abandoned town received from this time the name of Vittoriosa, in commemoration of its successful defence.

After the town of Valetta, and its front, had been completed, no further additions were made to the fortifications for seventy years. At the expiration of that time, an Italian engineer named Floriani was employed to improve the defences. He objected very much to the trace of Valetta, which he considered was too confined, and he therefore proposed to construct an additional line, which should enclose the entire of the peninsula. This work, which was at once executed, was called after him the Floriana, and forms now the suburb of Valetta. (*Vide* Plan.) Its design was objected to by many of the leading engineers of the day. Floriani, however, carried his point, and the work was executed in accordance with his plan.

Shortly afterwards, the Marquis of St. Angelo proposed, that, as the bastions of the Valetta front had such restricted flanks, four counterguards should be constructed, which would greatly strengthen the defence. These counterguards were executed as he proposed, as may be seen by a reference to the plan; but at the same time he, like the others, found great fault with the front of Floriana, which he considered had not a sufficient flank defence; and, as it was not possible to add to it from the front, he proposed to retrench the centre bastion in the interior, which was done. At the same time he gave a design for a work to be placed on the Point of Corso. It was not at that time constructed, but thirty years later it was carried into execution on the plan he had designed, and was called Fort Ricasoli (*vide* Plan), after the Chevalier Francesco Ricasoli, through whose liberality the funds for the undertaking were provided.

In 1638 Cardinal Fiorenzola, who, in spite of his ecclesiastical profession, was one of the leading engineers of that time, arrived in Malta, and he proposed a line of works to connect Senglea and Vittoriosa, which, although commenced at that time, were not completed for many years after. The works received the name of the Margarita lines. (*Vide* Plan.)

* *Vide* the annexed plan of the fortifications of Malta, which represents the fortress as it now exists.

In 1670 the Grand Master, Nicholas Cotoner, employed Count Valperga, a celebrated German engineer, to add still further to the strength of the fortress. This officer, at first, proposed merely a few additions to the Margarita lines; but Nicholas Cotoner was a man of grand ideas, and he was determined to execute something of stupendous magnitude. In accordance with his request, Count Valperga designed the Cotonera lines, an enormous series of works, consisting of eight bastions and two demi-bastions, extending over 9,000 yards, and completely enclosing the Margarita lines. (*Vide* Plan.) This design created a great ferment and much adverse criticism amongst all the engineering circles of Europe. It was considered that, in so extended a circuit, it would be impossible to maintain a regular trace without exposing many parts to great weakness.

It has always been a subject of astonishment why, when so stupendous a work was in contemplation, the design did not include the Corradin Hill, which has always been one of the vulnerable points of Malta. It might have been embraced within the line at a very small increase of expenditure; and it is a curious fact in connection with this point, that, in the palace of Malta, there is a portrait of Nicholas Cotoner, taken during his life, where he is represented as holding in his hand a plan of his new lines, and this plan does include the Corradin Hill. Whether this was a fancy of the artist, or in reality the original design, it is impossible now to say; but it is a fact that the work as constructed does leave out one of the most vulnerable points in the place.

The construction of these lines was carried on with great vigour for a period of ten years, under the immediate eye of Cotoner; but, after his death, the funds in the public treasury having become nearly exhausted by the vast expenditure, his successor stopped all further progress of the work, and the lines are to this day incomplete. Of late years, however, a considerable amount has been annually expended upon them; ditches have been sunk, ramparts and parapets completed, and in a few years the project, commenced in 1670, will at length be brought to a termination.

No further addition of any importance was made to the fortress until the year 1735, when the Grand Master, Manoel de Vilhena, erected a fort upon the island in the Marsa Muscetto, which, when completed, was called Fort Manoel, after him. (*Vide* Plan.) The object of this work was to command the two points of Dragut and Tasbieg, on either or both of which it would have been easy for an enemy to have established batteries, whence he could breach any part of the line of ramparts skirting the Marsa Muscetto. This would have been the more easy, as there were no ditches or counterscarps on any part of this line, and the escarps were consequently completely exposed. The breach once established, it would not have been difficult for the enemy to have carried their assaulting columns across the harbour in boats, and, an entry once effected on this point, they would have found themselves in the very heart of the town.

I have seen the estimate for this work. I do not say that I have seen the bill of cost after it was completed. Perhaps in those days, as now, estimates did sometimes fall very short of the mark. But, at all events, the estimate for that work, being a square fort consisting of four large bastions with a very respectable escarp and ditch, with barracks for 300 men and considerable magazine accommodation, was only 2,500*l.* Even assuming

that the actual cost did exceed the estimate, I suppose the work must have been executed for, at most, one-tenth part of what it would have cost in the present day.

It was about this time that the Order called in a body of artillery and engineer officers to report on the armament of Malta, and to propose a revision of it. I have read their report, and I have here some notes which I think will interest you, showing what was at that time, viz. 1735, considered the proper armament for a great fortress like Malta. They recommended that there should be

8	36-pounders.	208	12-pounders.
2	33 "	323	8 "
272	24 "	48	6 "
58	18 "	84	4 "
57	16 "		

Making a grand total of 1,060 guns, ranging from 36-pounders to 4-pounders; the favourite calibres, however, being 24-pounders, 12-pounders, and 8-pounders.

Perhaps I may also mention that I found a copy of the pay-lists of these officers. The chief engineer and the chief artillery officer each received 16*l.* per month, with fifteen rations of bread valued at one penny each, and eight rations of forage valued at sevenpence halfpenny each. The three assistant engineers and the two captains of artillery each received 12*l.* a month, eight rations of bread, and four of forage. The two lieutenants of artillery received each 8*l.* a month, with the same rations as the captains. One draughtsman was attached to each branch, who received 4*l.* a month without rations or forage.

In 1793, the last work built by the Knights in Malta was constructed under the auspices of the Grand Master De Rohan. This work, which is known by the name of Fort Tigné (*vide* Plan), occupies the extremity of the Point Dragut, the spot where, some 230 years before, that corsair had established the battery which was mainly instrumental in the fall of St. Elmo. Its name was taken from the Chevalier Tigné, who designed it. It consists of a battery of four faces in the form of a lozenge, with a circular tower as a keep in the gorge. It is probable that ere long this work will be greatly strengthened, as a glance at the map will show the extreme importance of the Point Dragut in commanding the approach to the port.

Such was the state of the fortress when the French Revolution burst forth, and drove the fraternity from their island home. We all know how Napoleon, on his way to the East, stopped at Malta, ostensibly only to water his fleet, but in reality with the intention of taking the island. Indeed, it is now well known, that before he left France he received distinct instructions from the Directory to effect the capture of Malta, provided that object could be carried out without any lengthened detention before its walls. With this view he asked permission for his entire fleet to enter the harbour and water there. Ferdinand Hompesch, the Grand Master (the only German who had ever attained that dignity), having strong suspicions that foul play would be practised, refused to admit more than two ships at a time. Upon which, Napoleon, making the refusal a *casus belli*, landed his forces, and in three days captured the fortress. Resistance there was little or none, for within the town treachery was rife; and not a few, even

amongst the Order themselves, looked with no unfriendly eye upon their French invaders. It must be borne in mind that nearly half the fraternity were French, and their feelings of nationality prompted them to encourage a movement which would hand over so important a military post to the possession of their own country. As Napoleon entered the gates of the fortress, crossing over the great ditch of Valetta, the largest and deepest artificial ditch in the world, he exclaimed to the officer riding by his side, "It is fortunate for us that there was some one within to open the gates; for, had they been locked, and the place left empty, it would have taken us a fortnight to obtain admission."

Having captured Malta, he proceeded to the East, and within three months of that time the battle of the Nile was fought and the French fleet in the Mediterranean annihilated. Meanwhile the French were treating their new subjects in Malta with great tyranny. They were ground down and harassed in every possible way; their religious prejudices were disregarded, and all the conditions, on the faith of which the town had capitulated, were systematically violated.

The immediate cause of the revolt of the Maltese was the sale of some of the ornaments of a church in Citta Notabile, the natives having been then, as they still are, extremely sensitive with regard to their religion. The revolt once commenced, spread like wildfire, and the French were speedily besieged by the inhabitants within their lines, all the remainder of the island falling into the possession of the Maltese.

At this juncture a Portuguese squadron made its appearance and blockaded the port, and within seven days afterwards Nelson himself arrived with his victorious but crippled fleet.

I should have mentioned that the first intelligence of the battle of the Nile, and its result, was brought to the garrison by the only three French ships which escaped from that battle, and these had taken refuge in the harbour. It is more than probable that the intelligence of this disaster to the French fleet had had considerable effect in prompting the Maltese revolt.

When Nelson joined the Portuguese squadron before the town, it was determined not to sacrifice life uselessly by attempting a regular siege, but to reduce the place by blockade, the command of the sea being so indubitably in the possession of the allies.

The commandant of the garrison was General Vaubois; and a narrative written during the siege, by a French knight named Ranzijat, contains a very interesting record of those two years' blockade. Incidents of importance, however, there were none; the principal events being the arrival every now and then, under cover of a dark night, of some small vessel laden with provisions, which, in the general scarcity, were always warmly welcomed. Nothing could exceed the cheerfulness and good spirit with which the French soldiery endured the privations of that blockade. For upwards of six months nearly their sole provision was the salad they raised in the ditches of the fortress, all of which they had converted into gardens.

The following is a list of the prices which provisions fetched during the latter portion of the blockade. After the first year pork was sold at 6*s.* per lb., cheese 7*s.* 4*d.*, rabbits 9*s.* 2*d.* each, fowls 2*l.* 8*s.*, pigeons 10*s.*, sugar 17*s.* 6*d.*, coffee 1*l.* 0*s.* 10*d.* per lb. Towards the middle of the year 1800, when they surrendered, oil was 1*l.* 3*s.* 4*d.* per bottle, sugar 40*s.*

per lb., and coffee 2*l.* 8*s.* 4*d.* per lb. Rats and other vermin had become recognised articles of consumption, and those that were found in the granaries and bakehouses were much sought after, from their superior size and plumpness.

In September, 1800, Vaubois, finding it impossible to hold out any longer, surrendered to the British force under Nelson, and the French evacuated the place. From that day the island has remained in the possession of the British. The short-lived treaty of Amiens decreed that it should once more revert to the Order of St. John, and, had it not been for the long-sightedness of Captain Ball, the then governor of the island, it might perhaps have again fallen into the hands of the French. Foreseeing that it was probable the provisions of that treaty would never come into operation, he protracted the time for handing over the island to Hompesch in every possible way. The result proved the wisdom of his conduct. War did once more break out, and the English retained their hold on the island. As a reward for his tact and judgment, Governor Ball received a pension of 700*l.* per annum.

The island has remained sixty years in the possession of England, during which time there have been two important additions carried out. One is a large casemated work constructed at Point Lascaris, and which is intended to sweep the great harbour. The other, and by far more important, work is that commonly known as "Harding's project," it having been designed under the directions of the late General Harding, whilst Commanding Royal Engineer at Malta.

The object of this work is to connect the Cotonera and the Margarita lines in such a manner, that, whilst the garrison might be too weak to defend the entire circuit as it now exists, they might retain possession of such a dominant portion of the space enclosed between them as would prevent an enemy from being able to occupy the remainder. To carry out this design, the project connects two of the bastions of the Margarita lines, with their intermediate curtain, with the same extent of the Cotonera trace. The connection is made by retrenchments of a bastioned form, and the space so enclosed is of a sufficient height to command all the ground comprised within the two lines. The two bastions on the Margarita side have been retrenched on their inner face by a defensible barrack, also of a bastion trace called the Verdala barrack. As this barrack faces the town, persons unacquainted with the principles which have governed the entire design have ridiculed the idea of constructing fortifications which face inwards, and have argued that as an enemy, to attack that side, must previously have forced both the Cotonera and Margarita lines, it seemed unnecessary to make such a powerful enclosure. As the work stands, however, the space forms a strong rectangular citadel, which could be held even after the whole of the remaining defences on that side of the water had fallen. (*Vide* Plan.)

Before closing my lecture I should wish to add a few words as to the present capabilities of the fortress for defence. I think it may be laid down as an undeniable certainty, that whatever nation maintains a maritime supremacy in the Mediterranean will eventually become the possessor of the fortress of Malta. Still, a state of things might easily occur in which a balance of power between two nations, even though only temporary,

might lead to the necessity of a defence of Malta from a regularly organised attack. In such a case it would doubtless be difficult for any garrison which England could probably afford to place within the fortress to maintain the entire circuit of works as they now stand. Still I have little doubt that, by a judicious concentration of resources, a garrison of even 4,000 or 5,000 men could maintain themselves within the fortress for a period of at least six months. The feeling of the population generally is pretty friendly, at all events it is not hostile, whilst the sixty years which have elapsed since the French held their two years' tenure of the place have by no means dissipated the hatred in which they are held by the Maltese. An ample store of provisions and munitions of war is maintained within the fortress. A very large quantity of corn is kept stored in "fosses" as they are termed in the island. These consist of conical excavations in the soft rock, of which the island is almost entirely composed, which are lined with cement, and form perfect dry receptacles, totally free from all danger of destruction by fire during a bombardment. They are the property of Government, but are rented by individuals, under the condition of always maintaining a certain minimum of grain in them. In the event of a siege this grain would of course be at once taken by the Government at a valuation. In the same manner, the contractor for the supply of fresh meat for the troops is bound by the terms of his contract always to maintain a certain number of head of cattle in the island. Thus all danger of a want of supplies is averted, without the expense of maintaining very large stores at the expense of the Government. There are, in addition, of course, large stores of salt meat and biscuit, which are the property of the Government.

One great difficulty with which a besieger would have to contend, would be the difficulty of constructing trenches and batteries in so rocky a soil. He would also be deprived of much of the advantage ordinarily attending a bombardment, as the houses, being entirely constructed of stone, even in their roofs and floors, it would be impossible to set fire to the town, or to effect any other damage than that which might attend the immediate fall of the shell.

Under these circumstances, it does not appear probable that Malta will be torn from our possession for many a long year to come; and any one who looks at the thriving state of the town and port, and sees the commerce which annually pours into the island, will admit that we have dealt fairly and honestly by our acquisition, and that the Maltese have no cause of complaint since they have become British subjects.

If war should break out—and in the present aspect of European politics who can tell how soon it may come upon us?—and if Malta should be one of the points of attack, as very possibly it may be, I am quite sure that, under the "meteor flag of England," the fortress will be defended as tenaciously, as heroically, and, I think I may venture to prophecy, as successfully, as it was in 1565.

Friday, February 1st, 1861.

CAPTAIN E. G. FISHBOURNE, R.N. C.B. in the Chair.

THE BRITISH TIDES.

By THE REV. H. M. GROVER.

WHEN these papers were written, Baron Humboldt's "Cosmos" was still in the hands of the public, and led the popular mind upon most of the physical obscurities of the day. One of the doctrines promulgated there was, that the great tide-wave of the earth circulated from east to west with the moon's diurnal course, instead of from west to east, in concurrence with her real motion in her orbit.* This doctrine appeared to be wrong, and the recent Admiralty chart is wholly confirmatory of the opposite hypothesis, being framed to show a tidal movement of the Atlantic from the westward and southward. The Atlantic tide moves across that ocean in a direction nearly from south-west to north-east, and that flow being repressed at an equal angle from the western coast of Ireland, the momentum of that vast movement will be directed from the coast towards the north-west, and acting by a repressive force upon the advancing wave, will make the course of that wave take a more direct northern course in those latitudes which lie beyond Ireland and the northern isles of Scotland. No doubt that repressed momentum will give way by degrees to the main drift of the Atlantic tide as it proceeds northward; but the effect of the new direction may account for the slow advances of the tide along the western coast of Ireland, from Bantry Bay to Achil Head, from whence there is found an entire contemporaneity of the tides with the very northernmost point of the Scotch islands. The tide, which takes $2^h. 20^m.$ to traverse the Irish coast from its southern point to the Head of Achil, 150 miles distant, along which it observes a pretty equal rate of progression, should occupy 5½ hours in reaching the Isle of Lewis at the north of Scotland, which is 400 miles from the River Shannon, if there were no diversion of the Atlantic wave in its approach to that more northern district; but delayed beyond its normal interval upon the Irish coast, it accelerates its culmination beyond that point, wherefore, by the cessation of the repressive action, a comparatively still water is generated. We regard it in this point of view, that taking the great Atlantic wave to continue under that state of repression which it meets with from the Irish coast, for a few degrees beyond the northernmost point of Scotland, the sudden adjustment of a common high water along the Scotch margin may be taken to proceed from that interception of the regular tide-wave in that latitude. For the course the repressed tide-wave would take is shown in the annexed diagram; and

* Cosmos, vol. i. p. 229, Sabine's translation.

though only such as the result of observation affords, it admits of the certain inference that, from some cause or other, the normal direction of that wave has been subjected to a diversion from its proper flow from the south-west (as found in the south of Ireland). The state of the Atlantic tides is well understood. But the result of calculations made in connexion with the present investigation, was to show that two contemporaneous high-water waves cross the Atlantic, at an interval of about 1000 miles. One of these waves is found to extend from Senegal in a line towards the American coast about North Carolina or Virginia, passing a few miles in advance of the Bermuda Islands to the northward, while the other or anterior wave will be found from a point about 100 miles south of Madeira, in a line towards Newfoundland; or a few leages to the northward of Halifax in Nova Scotia. The interval between these two waves is taken to denote the length of the Atlantic tide-wave in its ocean bed; and that interval in its mean dimension appears to be about 1000 miles. We say the mean distance, because the spaces between the same two waves differ on the opposite sides of the Atlantic; that on the eastern side being greater by about 200 miles than is found on the western. This probably arises from the sluggish state of the ocean in those eastern longitudes, while the flow of the Gulf Stream in the west gives animation to the ocean, accelerates the flowing waves, and shortens the intervals between them. Upon this point, however, the mere suggestion is offered, to which inquiry may be fairly directed.

The state of the tides on the Irish coast and in the neighbourhood of the Azores is wholly confirmatory of the interval here assigned to these ocean waves; for the tides at Bantry Bay, and at Fayal in the Azores, are very nearly contemporaneous tides: the distance between those two points being fourteen degrees of latitude; and again showing, therefore, the same proximate interval between the two contemporaneous waves in the ocean of about 1000 miles. The next point we have to discuss is the approach of this Atlantic wave towards the North Sea and the eastern waters of Great Britain. This appears to be from the north-west, and from that part of the ocean which is beyond the Shetland Islands. What we imagine to be the true state of the case is, as has been already suggested, that the Atlantic wave proceeds many leagues beyond Scotland before it recovers from its repression from the Irish coast, and in some new latitude. That repression being exhausted, a lateral and backward swell takes place from that bank of repressed waters, towards Norway and the Orkney and Shetland Islands. This is inferrible, because—while the traversing of the tide occupies only 2½ hours from the south of Ireland to Lewis Island, at the north of Scotland, 400 miles—there is an interval of full 4 hours between the tide of Lewis Island and the Orkneys, only 200 miles distant to the eastward; and there the tide flows through those islands with a most terrific violence, such as a rush of waters by the break up of a swollen bank would occasion, in addition to the tidal movement. As the tide appears upon the Norway coast also at an earlier time at Drontheim than at Bergen, it is by that shown that this arm of the ocean tide comes towards those regions in a direction from the north and west, and not, as in Ireland, from the south-west.

Our time will not permit any analysis of these periodical arrivals; but

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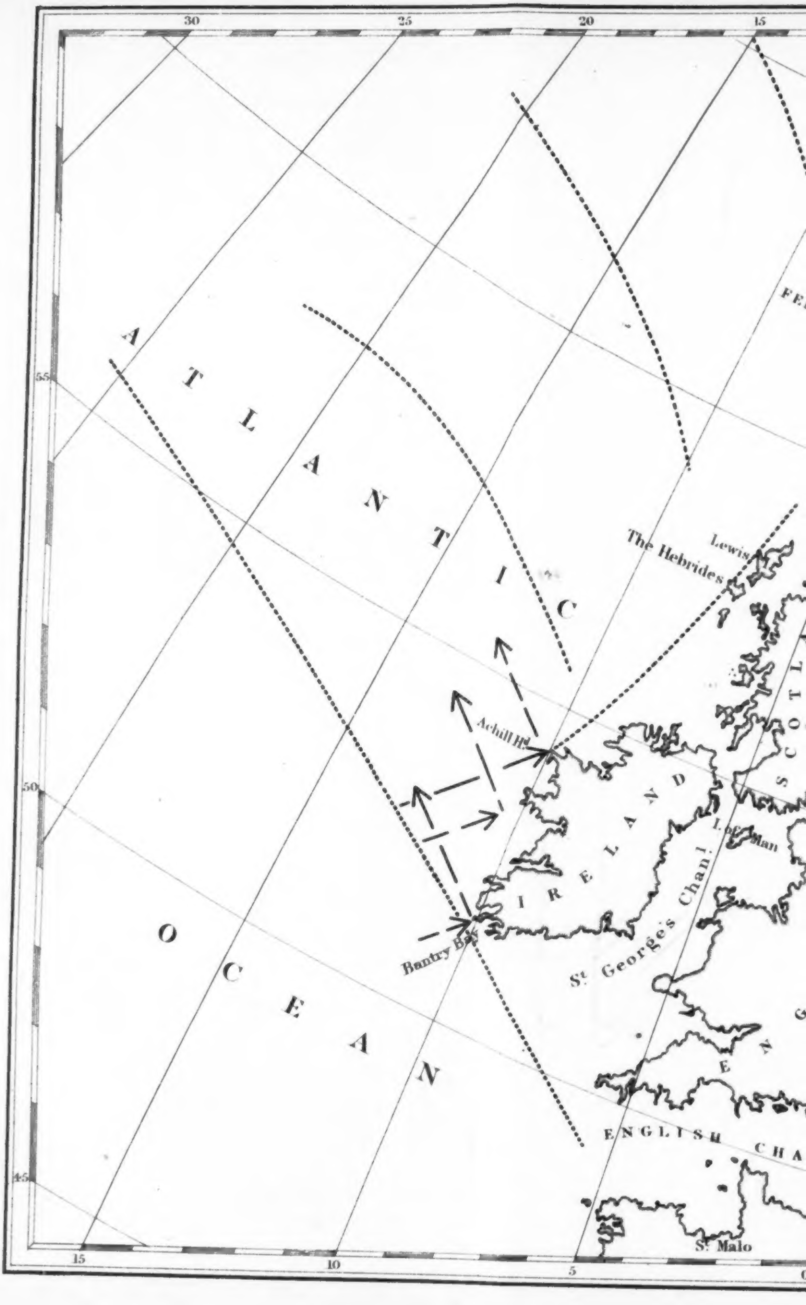
DIAGRAM



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ATLANTIC
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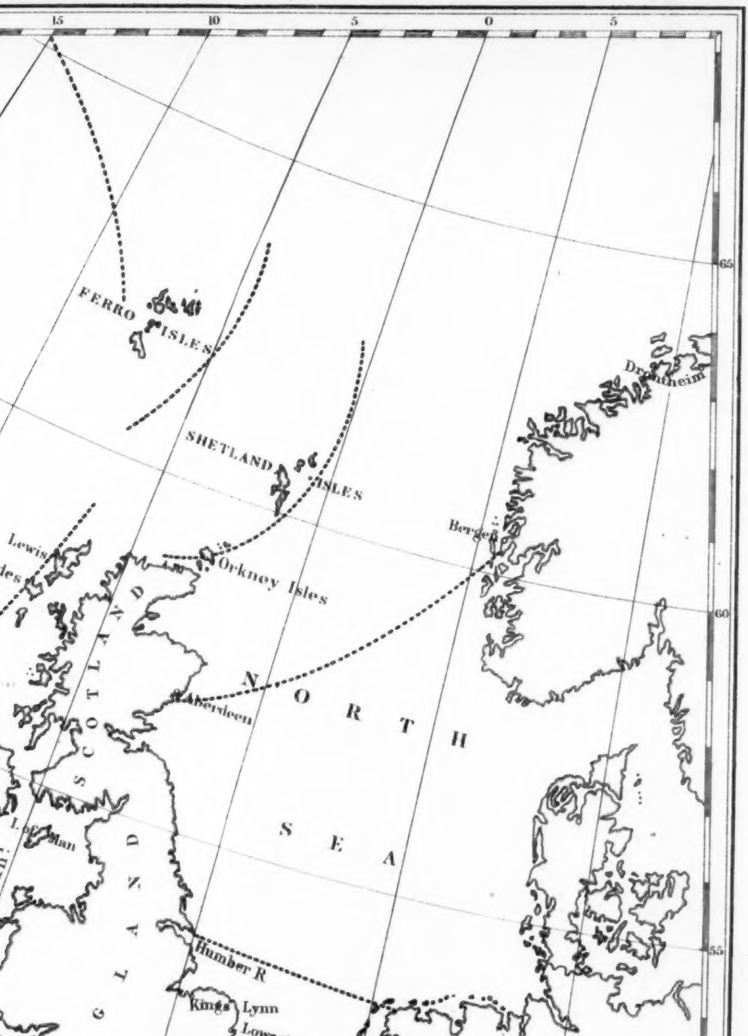
GRAM I.



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the lines in the diagram No. 1, will indicate the proximate conditions under which these waters have their tidal movements. The assumed bank of elevated waters, and its break-up into an ebb or refluent flow from its eastern limb, will be better understood when we have considered, as we purpose to do, the effects of the repelled momentum of these Atlantic tides upon the coast of Brittany by reflection from the Cornish coast, and the consequent flow of a new tide into the Brighton Channel from the broken bank of elevated waters in the bay of St. Malo and its adjacent districts.

The tide-wave of the North Sea seems then to be generated by a south-eastward reflux out of the Atlantic wave from a position some few leagues to the north of Scotland, and to enter the North Sea with a reduced momentum; as we may conclude from the length of its tide-wave, which we find to be about 670 miles, in lieu of the 1000 miles of the Atlantic wave. This moderated tide-wave is found then at the opening of the North Sea, marshalled from its refluent sources in one long array from the Scotch to the Norwegian coast. The Aberdeen and Bergen tides are contemporaneous tides, and a continuous line of high water lies between these two places at the same hour, and forms the incipient tide-wave of the North Sea. The tables show the tides at Aberdeen to be 56 minutes before the London standard, and those of Bergen, on the coast of Norway, 37 minutes after the standard; which, by a due allowance for the difference of longitude, shows the two tides to be within four minutes of contemporaneous occurrence. From this starting point the course of the North Sea tide-wave may be traced step by step along the whole length of that inclosed sea. For, taking the Aberdeen high water to happen at 56 minutes before 12 o'clock at night, the same wave will reach Shields about $0^h\ 15^m$ a.m.: it will reach the Humber at $2^h\ 25^m$ a.m., and Bremen, exactly opposite, on the eastern side of the North Sea, about 30 minutes later by the Bremen clocks: but, allowing half-an-hour for the precurrence of Bremen time to that of the Humber, it being about 8 degrees to the east of that longitude, those tides also will appear to be contemporaneous tides, as are the Aberdeen and Bergen. See Diagram 1.

Continuing southward on the English coast, the same tide-wave will be found in full culmination at King's Lynn at $3^h\ 40^m$ a.m.; but at this point it stays its progress to the south on that coast, for it does not appear at Lowestoft (only 30 miles further to the south than Lynn) till $4\frac{1}{2}$ hours after the tide at that place. In lieu of a direct onward course on the English side of the sea from this point, the course of progress is continued upon the coast of Holland, where the same wave will be found at the Hague, about an hour after the Lynn tide, or about $4^h\ 40^m$ a.m.; and, from that wave, by a ripple or reverted course, it reaches Lowestoft and the Norfolk coast about $8^h\ 20^m$ a.m., or about $4\frac{1}{2}$ hours after the Lynn tide. It seems quite obvious, from the course of succession here shown in the tides of these places, that the Norfolk promontory forms a direct breakwater to the western limb of this tide-wave, of which it turns the whole volume, under a single impulse, towards the east and to the coast of Holland. This deviation does not appear as a modification only of the course of part of its waters—such as a stream suffers in passing a buttress, which it avoids by a current round the obstructing point; but it appears rather as a diversion of the whole momentum of the advancing wave into

a new direction, like the rebound of a tennis-ball. As we have said, what appears upon the east coast of Norfolk and the Suffolk and Essex coasts, four or five hours after the Humber and Lynn tide, is plainly a ripple from accumulated waters on the Danish and Dutch coasts, from which a refluent flow wells forth laterally towards the west, and so reaches the English eastern coast—in the same way as the great Atlantic wave, repressed from Ireland in its course to the north, wells forth in a lateral flow towards the east, and supplies the Norwegian tide. This reflux of the detruded tide-wave may be traced in due succession along the Suffolk and Essex coasts, where it is first found at Lowestoft and Yarmouth about the same period, viz. about 8^h 23^m a.m., nearly 5 hours after the Lynn tide; then, at Aldborough 10 minutes later, and at Harwich about 45 minutes later than Aldborough—that is to say, at 9^h 23^m a.m.—whence the same wave reaches London Bridge at 12 o'clock at noon, having occupied 12 hours 56 minutes in traversing its whole course, from Aberdeen to that point. The tide-wave which we find at the Orkneys, flowing to the east from the Atlantic high waters, is thus traced, throughout its course into the North Sea, to its final termination in the Thames; and it is evident that the length of that wave is determinable. The regular sequence in the hours of its course from Aberdeen to Lynn on the English coast, and the contemporaneity of the tides at Aberdeen and Bergen, and again at the Humber and Bremen on the opposite coasts, prove beyond all doubt that this flow is of one great wave, that reaches across that sea from east to west in one continuous bank, and in that form pursues its course to the southward; while the interruption of that regular flow at Lynn, and its resumption in a due course of progress and augmented volume upon the Dutch coast, shows with marvellous certainty that the effect of the solid buttresses of the earth upon these tidal swells of the ocean is to turn the tidal flows completely from their course, and give a new direction to the momentum under which they are impelled. From this view of the subject, it will no longer be difficult to understand why the tides at the Hague precede those of Yarmouth and Harwich; since it is clear the tide is forced by the Norfolk promontory into another direction, and finds its course in a circuitous direction to the south parts of this sea. It no longer leaves any difficulty either in explaining the cause of those vast accumulations of silt and sand which form the soil and guardian banks of Holland; for they are plainly the drift of the English débris which the detour of the ocean turns upon those coasts, and which, being stopped in its course to the south by the influx of the Channel tides from the west, produces a continual deposit, whose effects are witnessed in the banks of the Dutch waters.

We have briefly before referred to the highly observable fact that the change of direction of the tide momentum, though so integrally affected as this tide is from the Norfolk coast, does not appear to be there accompanied with any apparent effects upon the Norfolk coast, upon which it impinges; and in that circumstance this inland tide-wave manifests a material difference from that of the Atlantic in its approach to the Irish and Cornish coasts. From these coasts the great ocean tide is repelled in the same manner as that of the North Sea from the Norfolk promontory; but the effects of that repression is manifested in an entire disruption of the whole

coast there, which, though of primitive rock, is absolutely torn to pieces by the violence of these tides, both in the south and west coasts of Ireland, and in that of the Cornish and Devonshire sea-boards. The Norfolk chalk is hardly at all affected by the rebound of its tide-water. There must be a reason for this difference; and the probable one seems to be, as we have stated, that this momentum of the tide-wave of the Atlantic ocean is accompanied by a moving stream also, of the Atlantic waters towards the north and east; while in the inclosed sea the momentum acts simply with its own impulsion, and as a mere undulation of a still water. The least impress of a forward motion on those undulations must give them a terrible power upon opposing bodies; while the mere elevations and depressions of overflowing waters can make none, or but a very small, impression upon them, and such only as might be occasionally produced when accompanied by violent storms or commotions of the ocean in its tidal operations.

There are several points open to investigation in the principles thus suggested in the tidal movements; and we feel persuaded that no satisfactory explanation will ever be afforded of those anomalies which exist on this subject until this law of the tidal momentum, and its distinct operations from the movements of the ocean waters in their beds, is thoroughly understood. Some few principal points have struck the writer as resulting from this distinction, which, without presuming to be certain on such a subject, appear to be open to observation. One is, that the momentum of the Atlantic tide is conjoined with a movement of that ocean from south-west to the east, arising from the influx of the Gulf Stream and its flow to the Polar Sea; another is, that, though the flow of the Atlantic waters does not at all pass into the North Sea, the momentum of that tide continues into the North Sea without a very great deterioration of its impulsive effects; and the solid momentum is never, in effect, lost, but pervades all the sectional tides, and all that supply their estuary waters, in some graduated proportions to the distance of the severed tides from those of the main ocean from which they have been disparted. The tides of the North Sea are certainly not the result of any direct action of the moon upon that mediterranean water; they are the residuum of the momentum of the Atlantic or cosmical tide, in its separation from that ocean, by the means which have been before pointed out. In recognising this law of a solid momentum in the tidal waves, we shall find explanation for several matters in the sectional tides. By this we shall perceive that any high elevation of such impressed waters—any tide-wave, in short, in its integral form—may retain its elevation and consistency for a period, and move even in a solid compages of its own amongst lower waters without at once losing its level, or suffering a diminution of its bulk; for the momentum will be one through the whole mass, and maintain the whole body in union, as a mass of loose materials of any other kind will be found to do under a similar impulsion; only this must be observed, that the momentum of the onward motion must be greater than the lateral pressure, or a disintegration of the mass will ensue. We point to this law in the present part of our paper, because it appears to solve many difficulties in the general consideration of the subject. But the principle will be found peculiarly important in the later portion of this inquiry, when we come to the con-

sideration of those laws by which the tides of the British Channel are constituted and maintained.

To return to the proper subject of our immediate discussion, the following scale of the contemporaneous disposition of the North Sea tides is presented to the reader, which will be found to put the point of their relational position to one another in a very plain view, and to afford at the same time a simple proof of the unity and continuity of that wave which we have traced from the Orkneys. In this scale the upper line, *a b*, denotes the high water, that marked *c d* the low water, at the different places and hours noted above each elevation or below each depression.*

Thus we see that the high water at the Orkneys is accompanied by a contemporaneous high water at Harwich, as is shown by the elevation of the same waved line to the high water mark at those two places, excepting only the 20 minutes' excess in every 12 hours' flow; for the Harwich tide above shown is properly the sequent tide; and the antecedent one, corresponding to that of the Orkneys in the preceding night, would have happened twenty minutes only before the 9 p.m. of that tide. The low water of that wave is found at the Humber, as shown by the depression of that wave-line to the low-water mark, and the half-tides at the two intermediate places will be Leith and the Hague. The London high water corresponds in the same degree with a high water at Leith, having the corresponding low water at the Hague. When a low water prevails at the Orkneys and Harwich, the North Sea wave occupies the midway of that sea at the Humber, and the half-tides are found at Leith, the Hague, and London. The quarter-tides are found by the same scale at the intermediate junctions of the diagram, and their corresponding places might easily be marked. It is apparent from this disposition, that the North Sea tide is formed by one great wave from the Atlantic, generated, as we have seen, by a revulsion of the ocean tide-wave in its passage to the north between the Norwegian and Scottish headlands, and traversing that sea under an original momentum, and in one volume, to the extremest point of its course southward. The length of this wave from the Orkneys to the Hague, which is only a three-quarter flow, is about 500 miles, making the direct flow of a full tide equal to about 670 miles.

On the subject of the reflected momentum, which is the point that has appeared to the writer most deserving investigation, he must state briefly what has struck himself as observable on the subject. The first point is, that the tidal momentum operates in an integral volume, and passes into the waters which lie in a direction that is opposite (geometrically) to the impinging wave, and in equal volume to the advancing wave that brings up the momentum. From this cause the reflected momentum will be found operative at great distances in its opposite path in very short periods. This is manifest in the reflected tide of Cornwall upon the coast of Brittany, which rapidly succeeds the original impact upon the British coast.† The same thing is observable upon the North Devon and Somersetshire coast in the Bristol Channel by the reflected momentum of the ocean tide from the Pembroke coast, in the south of Wales, What we think illustrates this is, that we may imagine a line of billiard balls touching one another, and so disposed as to receive the rebound of the impinging ball from the cushion

* See Diagram II. † See Diagram III.

DIAGRAM III.

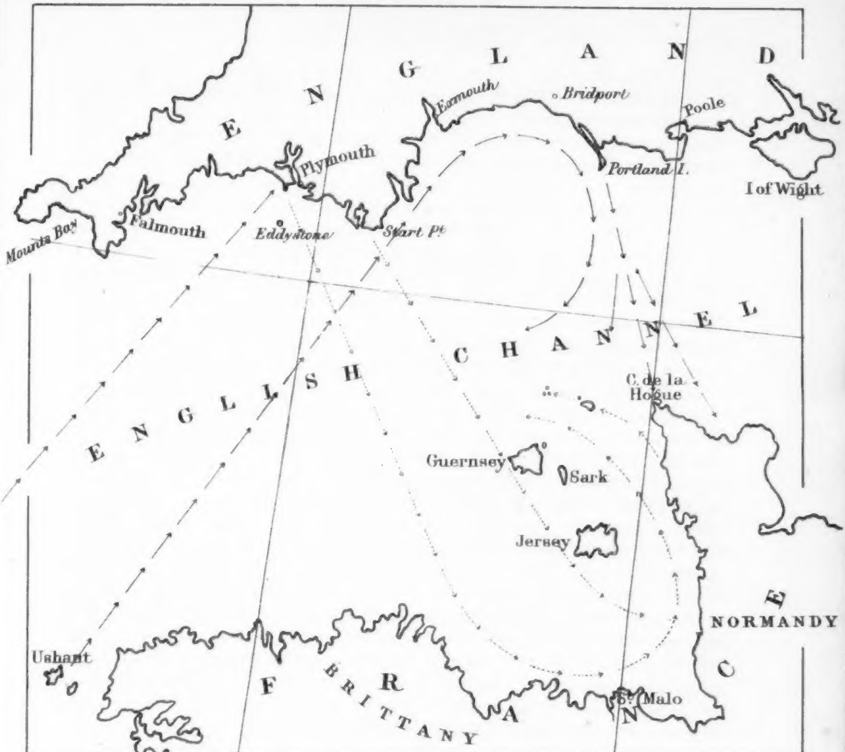
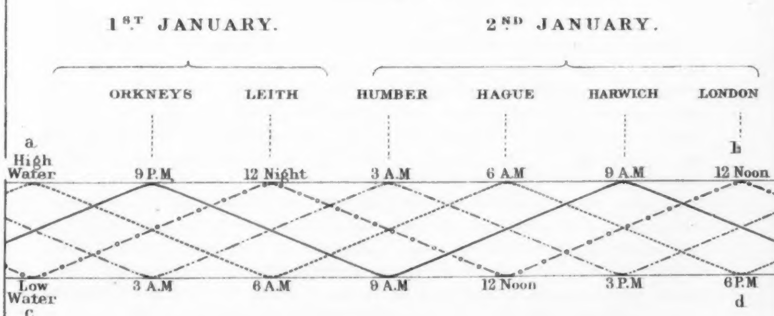


DIAGRAM II.



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in the same line as its proper direction would lie: the momentum of the impinging ball as it struck the nearest of that line of balls would operate almost immediately upon the most distant one, and impel it forward as the first apparent effect of the transmitted momentum. Just so the tide waters which bear the momentum of the Atlantic tide upon the Cornish coast shows a very early effect upon the waters on the coast of Brittany, where its operations are almost the same as on the opposite shores, but more developed in the magnitude of the effect.

Next, it is obvious, that there is a difference in the momentum of the Atlantic tide-wave and that of all inland waters; that the one is accompanied with a more determinate force than the other. The mere tidal wave appears as the uplifting and depressing only of a stationary water, which has the flow of the sinking wave as a mere surface ripple, without weight or violence. This is not the case with the Atlantic wave in its northern aspect; for that is accompanied with a flow or stream in the whole body of its waters, from the effect of the Gulf Stream, which, small as its apparent motion may be, unites its more active momentum with the tidal momentum, and, in its combined form, falls with terrific force upon the coasts that it approaches. The repression of the tide wave from the Norfolk promontory, and its effects, have been already noticed; there, though the tide-wave moves at the rate of 750 miles in the twelve hours, no mark of extreme violence is apparent: placed in Cornwall, that chalk bulwark would be torn to pieces in a fortnight. On this point I will only observe, that the limit of its operation on the Cornish and Devonshire coast, affords a very substantial argument in favour of the assumed direction of the Atlantic wave from the south-west; for, flowing from that direction, the direct force of the Atlantic wave could not reach that south coast of England beyond the range of the French coast to the southward, in a line with its flow. Ushant, the extreme west point of that coast, lies due south-west of Exmouth; and, if the Atlantic tide-wave moves in a line from the south-west, Exmouth would be the extremest point to the east that the direct flow of that wave would touch; and it is *precisely* within that limit to the westward that all the violence of the approaching tides has left its marks; corresponding to those found on the south and west coasts of Ireland.

This enables us now to proceed to the Channel tides.

To ordinary inspection, the course of the British Channel appears a clear and open sea, to receive the ingress of the ocean tide from the Atlantic, which it might wash with an even swell from one end to the other—nothing can possibly be further from the truth than such an easy hypothesis. So far from an even and equal flow of the tide waters, which would infer a gradual deepening, and even time-keeping of the tide all up the Channel, we find the deepest tides in the Gulf of St. Malo, where they surpass those of Plymouth, though that gulf, by its southern and embayed position, one would have thought, was least exposed to the great swells of the ocean tide. So far from flowing up the Channel with an even course, the flowing tide, which reaches Portland Road from the Land's End (a distance of 150 miles) in about one hour and three-quarters, stops short at this point, so that the Isle of Wight tides, only fifty miles further on, do not take place till five hours after the Portland; and though the Alderney

Island is within a gun-shot almost of the French cape of La Hogue, the tide of the former, which tallies with the course of the Portland tides, has no connection with, or dependence upon, the tide of the latter at all. But the very same hour that is the hour of high tide at Alderney, is the time the tide is at its lowest ebb at La Hogue.

But the matter loses its mystery if we recur to the principles observed in the movements of the tide-wave under opposing forces. The Atlantic wave in approaching the British islands from the south-west falls diagonally upon the Cornish and Devonshire coast, and its momentum, repressed from thence, rebounds in volume upon the French coast, and is cast into the Gulf of St. Malo, where the strong tides of the ocean wave appear again in full force, as we have seen. The course of this reflected tide may be traced round the bottom of the French gulf and along the sides of the Norman promonotory, which bounds it on the east, in its recoil from the north-western impulse, with which it is projected into that bay, till it fairly reaches the boundary of its course at the island of Alderney, the last and latest tide of that movement. At this point it meets an eddying wave, flowing also in reverse from the Dorsetshire bay whose shores it has circulated round, and from which it has emanated by the Portland Head, which forms its eastern boundary. These circulating waters from the south and north form here a confluence, in which the momentum of the ocean is lost, and a head of broken tide-waters formed, out of which a free and ample flow commences towards the upper Channel and the Portsmouth waters eastward, while its western limb falls in at the same time with the ebbing tide of the Atlantic, towards the mouth of the Channel. From this source the western flow of the Brighton Channel is supplied.

But we must begin at the beginning and pursue the subject methodically. From Mount's Bay, adjoining the Land's End, to the Start Point, in Devonshire, the Atlantic tide-wave approaches in a direct course, and casts its waters upon that shore in a full and unbroken volume. This is effected along this part of the coast by a slow progress, suitable to the diagonal position of the wave; for the difference of the tides of Mount's Bay and Plymouth amounts to—

	hrs.	mins.
Mount's Bay, add	2	33
Plymouth, add	3	26
	0	53

about 53 minutes, or, with the longitudinal increase, about 57 minutes; while the distance is only about 55 miles, or equal to a flow of 830 miles in the tidal period of $12\frac{1}{3}$ hours. But if the wave approaches this coast at an angle of $22\frac{1}{2}$ degrees, as I think it does, one-half that difference must be added, to show the true perpendicular flow of this tide-wave, and that would give 1,070 miles, showing again the 1,000 miles as the proximate length of the Atlantic wave. The direct flow of the Atlantic tide-wave cannot reach further than Exmouth, eastward, on the English coast, for the Bretagne promontory will intercept all to the east of that line. Then, how does the Atlantic tide gain access to the superior parts of the British Channel above this eastern boundary of its direct flow?

It is clearly not by a flow from the west in a direct course, because then the same water which forms the Dorset tide would pass into the upper parts of the channel; but the Dorset tide does not extend beyond the eastern boundary of its bay at Portland Head;—the Christchurch and Isle of Wight tides have altogether a different dependence and course of tiding. It appears probable that a small section of the direct tide-wave from the ocean is urged laterally over the lip of the Devonshire Basin at the Start, and forms a circuitous flow round the Dorset Basin, from which it issues to the south of its eastern headland, and combines with the head waters of the St. Malo Gulf, about the locality of the Channel Islands.

The course of these tides is highly remarkable. The high water at Bridport takes place about half-an-hour after that at Plymouth; that of Portland Road 15 minutes later; and these appear to follow in due succession to those of the Land's End and Plymouth; but the tide of Cowes, in the Isle of Wight, only 50 miles further on than Portland Road, with an open sea from the west, does not attain its height till 5 hours 20 minutes after the Portland Road. This is precisely such as happens upon the Norfolk coast, where, though the tides succeed in regular succession along the English coast from Scotland to Lynn, at an average rate of about 50 or 60 miles in an hour, there a break takes place in their progress, so that there is an interval of 4 hours between the tides at Lynn and those of the east coast below that promontory, within 30 or 40 miles, as we have already seen.

The tide at Southampton follows the Cowes tide by 55 minutes, and at Portsmouth it is at the same hour as at Southampton. Beyond Portsmouth, to the east, the tides precede those of the Southampton Water, and give evidence of a flow from the east. The Shoreham tides preceding the Portsmouth, and the Brighton preceding the Shoreham, the flow into these estuaries must consequently be both from the east by Spithead and the south by the Needles at the same time. The waters enter both ways at flood, and retreat both ways at ebb. This circumstance, and the five hours which intervene between this flood and that of Portland Island Channel tides, show that they are both evidently a supplementary flow from the head of a subsiding wave to the south of the Isle of Wight; and from that wave, which entered the channel at Mount's Bay six hours before, and was found at Portland Road two hours afterwards.

In diagram No. 3, the opposite coasts of England and France at the lower part of the British Channel are shown, and the line of incidence and reflection of the tide wave of the Atlantic upon the Cornish and Devon coasts shown by the figured arrows in the two directions; and if it appears that that angle is not mathematically true, and that the Plymouth waters would hardly reach the opening of the St. Malo Bay, yet may it be believed, under the strong evidences which support the fact, that such a reverberate action does take place upon the tide-waters in their approach to this coast, as effectually to cast the high-water tide from one side of the channel to the other, and in that direction. We shall not fail to observe that the Cornish bay, in the west side, on which Falmouth is situated, has a direction tending to the north-east, from which the heavy wave of the Atlantic tide, when urged along it, would act as a wedge upon the more eastern waters, and divert them into a more obtuse angle than they would naturally gain by impinging upon a directly

opposite coast. The point need hardly be pursued further, however, as any accuracy in this stage of the inquiry cannot be pretended. There is sufficient to show that the principle of a repercussive law operates upon the tide-waves of the ocean in mass, and produces a rise of the adjoining waters by the recoil of the momentum from the advancing ocean-wave; approaching the opposing coasts in a direction antithetical to that of its line of approach. As we proceed, we shall find the development of the channel tides, and all the anomalies they disclose, fully explained and accounted for by the effects of this rebound of the tidal forces. At present we must be content to show the sequence of the-tide waters round the bay of St. Malo, which will be found to be such as is accordant only to an entrance into that bay from the north-west, and by a direct and strong set round the bottom of the bay from north and west to south and east; from whence the stream circulates up the Normandy promontory from the south to the north, and loses its momentum only when it has recoiled back by the Channel Isles towards the mouth of the channel. For the ocean tide-wave which first touches the Land's End at $2^h\ 23^m$, is found at Plymouth at $3^h\ 26^m$, and St. Malo. 27^m only later; viz., at $3^h\ 53^m$. From thence the tide moves to Granville, more east; but still near the bottom of St. Malo's Bay at 4.2, and from thence reaches Alderney, which it approaches from the south at 4.38, and Guernsey a few minutes earlier, showing its access to the eastern side of that bay in which St. Malo is placed, by a detour round the circumscribing area, as the North Sea wave does round the coast of Holland, by which detour it approaches the Nore waters after its repulsion from the Norfolk promontory. The tide-waters in the Dorsetshire bay, opposite to St. Malo, have in the mean time moved out of that bay by a similar circuit, from some half-direct injection of the ocean-wave at its western edge, which has visited Bridport at $3^h\ 53^m$, and from thence reached Portland Head at $4^h\ 8^m$, and moved on in its recoil towards Alderney and Guernsey at 4^h 23^m; for this tide does not advance towards the Isle of Wight at all, as has been before shown, though there is an ullage from it, or back-water, towards St. Alban's Head and Christchurch. The course of this double gyration round the bays of St. Malo and Dorsetshire is designated by the lines of indicating arrows in the diagram, which are drawn round the two eastern coasts, and revert towards a common focus between the islands of Alderney and Guernsey. By this gyration of its waters in the opposite bays, the Atlantic wave is brought to a standstill and its momentum destroyed, and the limit of this cauldron in which the evolution is performed is bounded by a line which may be drawn from Portland Head to Cape la Hogue, with as much precision as if a wall were built between them. For the tide of Cape La Hogue sympathises with that of the Portsmouth water, being within 20 minutes of the time of that tide, and quite as much as those of Brighton and Southampton waters; while the tide of Alderney, though within gunshot of the French cape, sympathises wholly with the Dorsetshire or deep-sea tide, and differs with that of La Hogue, 12 miles off, by nearly 6 hours.

Brought to a stand-still, and its momentum broken, the head of waters in the mid-channel gives way on all sides, and pours its streams into the up-channel, to the east, and downwards, as an ebbing tide, to the west, and

opening of the channel; and in this process, from its two extremities, the Portsmouth and Southampton waters receive their first supplies of a flowing tide, from the two opposite entrances of these estuaries. It will be obvious, however, to anyone who reflects on the nature of this head of waters, and the relapse of its waters to the west, that it bears no real analogy whatever to a mere tidal ebb,—because, of an ebb tide, a full flow of the flood tide to the end of its course must be predicated; but this body of water does not attain any end to its course, for its momentum is broken in the midst of the waters, and upon the very verge of a low-water basin, for such the Brighton Channel is, at the moment that the St. Malo and Alderney water is standing in a paralysed heap, 40 feet in height above the level of the ocean low-waters. The provision is clearly a contrivance to prevent the flow of the Atlantic tide-wave directly into the channel; such as the Norfolk promontory is; and save the crash that must ensue if it met the tide of the North Sea in full career as it came down that channel. The detour of waters upon the Dutch coast, in their descent from the north, has no doubt the same object, and softens the rigid effects of a direct flow into the Straits of Dover, by producing a gyration of the North Sea tide towards the Nore waters and the basin between the two English forelands of the Kentish coast. Thus there are three safety revolutions produced to bring about a peaceable meeting of the opposite waters in the Brighton division of the British Channel: two, of the waters of the Atlantic, which are divided upon the Start Point, one-half being driven round the Dorsetshire Bay, and the other half, by repulsion, being driven round the St. Malo's Bay, and both brought into a common aggregation to the west of the La Hogue and Portland headlands; and one, of the North Sea, which is diverted from its direct southern course by the Norfolk promontory, and made to gyrate round the coast of Holland, and lose its momentum upon the sands of the Nore. The effect of these provisions is to ease the advent of these opposite tides on their meeting. The circuitous motions of the St. Malo tide upon the west end of the Brighton Basin is to reduce the height of that tide from that side of the basin to half its proper elevation, and so probably serves to equalise it to that of the North Sea; for the tides of the Nore Basin synchronize with those of Brighton, and rise and fall in the same order; while the tides of the St. Malo's section are exactly in the reverse order, so as to be at flood when the other section is at ebb. The tables show this distinctly: for the Harwich and North Foreland, Brighton, Shoreham, and Chichester, are all noted by a subtraction of about 2½ hours from the London tide, and the St. Malo, Alderney, and Portland Head, by an addition of from 4 to 4½ hours; making the exact 6 hours' difference between the flow and ebb of the same tides.

When the ebb commences at Alderney, the flow commences from the same point into the Brighton Basin. At that time the ebb will have prevailed above 2 hours at the mouth of the Channel, and before the 6 hours' ebb at Jersey has run its course there will be a 2 hours' flow at the mouth of the Channel, and a rising tide which will repress the Jersey ebb tide by nearly half its decline. In effect, the Alderney Basin can never be lower than about a half high-water of the ocean tide; and by that constitution the equilibrium of the Brighton waters with that and the North Sea head of waters is maintained. The tide of the Brighton and

Dieppe section of the Channel is properly a sectional tide. The action of this sectional flow and ebb is traceable as far up the Channel as Christchurch, where the flood tide takes place about 3 hours after the Portland and Alderney, or about the half ebb of those tides, and shows the state of the Alderney low-water mark very distinctly.

The contrast of the lower and upper channel waters is very remarkable: on the same day that the Brighton waters ebb from 9^h 0^m a.m. to 3^h 10^m p.m. the Plymouth waters rise from 9^h 17^m a.m. to 3^h 27^m p.m. It is very observable, also, that from this combination of the tide-waters in these two basins, there is always a double flow of tide to be obtained by ships in going up the Channel; so that if a vessel could leave Plymouth with the first flowing of a tide from that point, it would fall in with another young tide, after a six hours' voyage, about the Channel Islands, which would carry it up the upper channel for another flow. The distance is not above 80 miles, and it might be accomplished by a steamer, so that if such a vessel fell in with the flow of the tide in the meridian of Plymouth at 9 o'clock a.m., and reached that of Alderney at 4 p.m., it would find the ebb from that high water flowing into the Brighton Channel as a young tide, which would carry it to its flood after another seven hours' voyage. To take the benefit of that flow, however, the vessel should keep on the French side of the Channel from the Alderney waters, as we should keep the English side in a returning voyage.

Having thus traced the gyrations of this great Atlantic wave in the Channel basin below the line of division between La Hogue and Portland Head, and shown the bank of head-waters established with its broken momentum between the Dorset and French headlands, we will proceed to show the tidal operations in the upper channel, in connection with this disposition.

It must here be borne in mind, that the upper or Brighton and Dieppe channel, which embraces the Portsmouth waters, does not depend wholly upon the western or Atlantic tide for its supply; but derives one-half of its waters, or some other proportion, from the North-Sea tide, through the Straits of Calais and Dover. The flow of waters sets in to the Upper Channel from those two opposite points, at nearly the same hour. It is low water at Calais at 4 o'clock, p.m., the same day that it is high water at Guernsey and Alderney at 4^h 30^m p.m. At Dover the low water is forty minutes earlier than at Calais; the waters begin to flow into the Channel, therefore, about four o'clock from the Dover Straits, and about half-past four o'clock from the Alderney Head waters: the difference is, that the western flow comes by the fall of a head of waters, or ebb of the encaged wave of the ocean-tide from the Atlantic, while the eastern supply is by the natural flow or rising of the North Sea tide at that point, where it enters the Channel. The Alderney tide falls half the height of its full elevation above the ocean low-water; and the North Sea, being a sectional tide itself, rises half only of the full elevation of the ocean waters, from which it is derived. The rise and fall of the opposite sources will, therefore, equal one another, and afford a mean elevation at the end of their period of flooding. The adjustment of this counter-flood from the two seas is again very extraordinary, for the North Sea waters appear to keep their course along the north side of the Channel, and those of the western waters

along the south or French side; at least the entering of the tides on the two coasts move in that order, and in the reverse way to each other.

Their sequence is as follows: on the French coast, having a high water at the Alderney Pier at 4^h 30^m p.m., the high water will follow at Cherbourg at 5^h 23^m p.m.; at Havre de Grace at 8^h 10^m p.m.; at Dieppe, more east, at 9^h 23^m p.m.; at Boulogne at 9^h 44^m p.m.; and at Calais at 10^h 6^m p.m. On the other side of the Channel, the Dungeness tide, which precedes the Dover tide by about a quarter of an hour, will have had its ebb, or beginning of flow, about 3^h 0^m p.m. on the same afternoon, and its flood at 9^h 10^m. At Beachey Head the same order will be observed, eighteen minutes later, or with its high water at 9^h 28^m p.m.; at Brighton, nine minutes after Beachey Head, and at Shoreham and Selsea Harbour, eight minutes later; making the high water of those two places at 9^h 45^m, which is the period that the counter-flow carries the high tide up to Boulogne, whose tide we have seen is at 9^h 44^m. The mean point of the two floods appears to be about Dieppe and Beachey Head, where the high waters occur about the same time, viz., about 9^h 25^m p.m. The cause of a set of the North Sea waters towards the north sides of the Channel may be explained by the course which the North Sea tide has been shown to take by the coast of Holland; for a sweep of those waters from the Norfolk headland round by that coast would carry the section which reached the Straits of Dover, through these straits towards the north; but on what principle the Alderney head-waters take a direction to the south is not apparent, except it may be attributed to a stress of that body which issues with a sweeping motion to the south out of the Dorsetshire bay and by the Portland Head, which probably is the cause; and is in itself analogous to what is seen to happen at the other extremity of the Channel.

These dispositions have presented themselves as one of those marvellous dispensations of the Great Ruler of the earth, by which the vast ocean is ordained to be at peace and its violence tamed into subjection. They can hardly, we think, be regarded as altogether casual. Take away any one of the conditions here exhibited in the arrangement of the North Sea and Channel tides, and the whole area of this meeting of the waters would become a scene of confusion and ruin. As it is, the whole combine together in time and space in such a way as to produce a complete harmony; the two tides being in a manner dovetailed together, and so regulated as to preserve their proper path without any interference with each other. The subject is new to ourselves, and, we believe, open to much investigation. What we have here suggested must be regarded therefore as an outline only of this supposed system; and, in conclusion, we will merely shortly trace the courses of the two tides in their approach to their final goal, which for this purpose must be taken to be London. For thus it appears to be, that the Atlantic tide-wave which passed the south coast of Ireland, say Bantry Bay, at two p.m. yesterday, would be found at Harwich at 10^h 30^m this morning, having traversed round by the Orkneys, where it would have been at 10^h 30^m last night; while the tide-wave, which was at the same south point of Ireland this morning at two o'clock, would have reached Plymouth, in an eastern direction, at 3^h 30^m this morning; attained its point of culmination about the Channel Islands at 4^h 30^m a.m., and, passing Calais at 10^h 6^m a.m., have been at the South Foreland also at 10^h 30^m

this morning, and so contemporaneously with that of the Harwich high water. These two places, Harwich and the South Foreland, whose tides are, as I have said, contemporaneous, may therefore be regarded as the extreme points of the basin out of which the London tide-waters are supplied. Two hours and thirty minutes before the London high water, the tides culminate upon Harwich from the North Sea, and upon the South Foreland from the Channel. They meet in crossing the Nore, an hour and a half after the Harwich and South Foreland tides; and the tides which have been traced to these places this morning at $10^h\ 30^m$, will therefore have reached their destination at London at one o'clock this day.

Friday, February 15th, 1861.

Colonel PHILIP J. YORKE, F.R.S., in the Chair.

THE MILITARY FORCES OF THE NATIONS OF EUROPE.

By Captain MARTIN PETRIE, 14th Regt. Topographical Staff.

It will be my endeavour to-day to give some account of the Military Forces belonging to the several European powers.

At the present time, we can hardly be unconscious of the immense development which the warlike resources of each nation are receiving every day, and the great and growing importance attached to the naval and military element by the governments of every state in Europe; one nation striving to rival another in the extent and the perfection of its armaments. Administrative talent was never so severely taxed to increase the *personnel* available for an army; and the powers of science and art are exerted in an equal proportion, to originate new implements of destruction, or to devise means of safety from their tremendous effects.

Abroad, the mighty engine of the conscription extends its resistless grasp in every direction; whilst at home, the free youth of Britain respond to their country's call—the gleaming bayonet is a welcome ornament in the quiet hamlet or the mart of industry, and one smile of acknowledgement from a monarch whose securest home lies in the hearts of her people, is deemed an ample reward for every exertion and fatigue.

While the marshalling of men is proceeding thus, fresh fortresses are rising through the length and breadth of Europe; colossal walls of stone, and even of iron, with tortuous labyrinths of ditches, spread far and wide, in the endeavour to guard each point vulnerable to a foe.

The ocean, once speckled with the white flowing canvas and tall masts of our wooden castles, in these days bears on its surface the huge smoking armadillo of iron, less picturesque, but more mischievous; and, when we come to the workshop, we find mechanical contrivance no longer limited to the crude weapons of a few years since, but creating structures whose vast proportions the Titans might envy, yet whose delicacy of finish the most expert fairy could hardly excel.

France, though professedly not arming, or placing her forces on a war footing, is straining every nerve to bring her troops to the highest state of efficiency, to have them prepared for action at a moment's notice, and "in a condition to meet all emergencies." The *matériel* of her army is being improved and remodelled with all the aids that science or ingenuity can suggest, and her naval arsenals resound with the echoes of ten thousand hammers, under the strokes of which not less than thirteen iron floating

batteries are gradually rising to completion; these, when launched, will form a most formidable addition to the already powerful maritime forces of the country.

Prussia, too, is endeavouring to organize her army on a more effective basis than hitherto, to improve the arms and equipments of all branches of the service, and to strengthen her frontier fortresses in every manner that is practicable.

Austria, though exhausted and shaken by the events of the last two years, is, nevertheless, making ready for a contest; the points open to attack will now be strengthened with works on the newest principles of art, while the famed Quadrilateral bristles with bayonets, and the Kaiser is preparing to confront the louring storm.

Italy tells us of a million of bayonets to be assembled in the approaching spring, to consummate the vindication of that national existence, which has so long been the aspiration of her statesmen and the theme of her poets. Mysterious cargoes of arms and warlike stores are stealing eastwards to the Principalities, with the view of effecting such a diversion in Hungary as shall compel Austria to relax her eagle grasp upon Venetia.

Nor is the Colossus of the North idle. Profiting by the experience of the late war, the Czar Alexander is endeavouring, while reducing the numbers of his unwieldy legions, to increase their efficiency by adopting all possible improvements both in the administration and the material of his forces; and, though foiled in his ambitious projects of territorial aggrandisement in the West, is advancing by gigantic strides along the coasts of the Pacific Ocean, and gradually enveloping the northern provinces of the Chinese Empire.

The secondary powers of Europe, also, are not indifferent. The Spaniards, the Belgians, and the Dutch are "sharpening their cutlasses," as Sir Charles Napier would have said; and the Danes, still more active, are commissioning their navy, and placing their regiments upon a war footing, determined to show their opponents that now, at all events, "there is *nothing* rotten in the state of Denmark."

Europe, as it is at present politically divided, consists of fifty-two separate kingdoms and states, the largest of which is Russia, and the smallest the little republic of Andorra, situated somewhere among the snowy peaks of the Pyrenees; the military power of this last, however, can be safely regarded as of no great weight in European combinations.

Of these states we may reckon *five* whose military and political strength entitles them to be called First-rate Powers. They are—

Austria, Russia,
Prussia, France,
Great Britain.

To the five we hope soon to see a sixth added. I allude to the Kingdom of Italy, which, despite all obstacles, promises ere long to

become an influential country, with a government, less paternal it is true, but more constitutional, than those of its neighbours, whose exertions in the cause of "order" are continually producing such violent convulsions. Let us trust that the Italian nation, which has already won the warmest sympathies of all Englishmen, may ever be our allies in arms.

I shall commence with a notice of the German powers, reserving a view of our own land to the last.

Austria and Prussia are, as you well know, the two leading states of the Germanic Confederation This latter body may be considered as the existing representation of the old German Empire, and includes no less than thirty-six separate kingdoms and duchies. Its extent is defined by the red tint upon the map.

The present constitution dates from 1815, but it has since undergone some modifications.

You will observe that Posen and Prussia Proper do not form part of the confederation; neither do Hungary, Gallicia, the Austrian provinces bordering upon Turkey and the Adriatic, nor Venetia. On the other hand, the Duchies of Luxemburg and Limberg belonging to the Netherlands, and Holstein, which appertains to Denmark (in virtue of the king of that country being its duke), are constituent portions of the Federal territory.

The fortresses of Mayence, Luxemburg, Landau, Ulm, Kehl, and Rastadt are Federal strongholds, and always garrisoned by mixed contingents.

The species of divided allegiance thus engendered constantly gives rise to political complications. We are just witnessing an example of one of these in the Schleswig-Holstein question.

The territory of the Germanic Confederation includes an area of 243,000 square statute miles, and has a population of 44,000,000.

The principal provisions of the Federal military laws are as follows:—

In time of peace, the general supervision and control of the army is vested in a committee of the Diet, in conjunction with a consultative military commission. The actual command of the forces, however, is exercised by the governments of the various states.

Upon a declaration of war, the authority of the several German princes over their troops ceases and determines, and the supreme command devolves upon the Diet, by whom are appointed the commander-in-chief, and several other principal officers. From this body also all orders relative to the distribution, movements, and action of the Germanic forces emanate.

The strength of the contingents to be furnished by the different states is fixed at $1\frac{2}{3}$ per cent. of the population as it existed in 1815, or about 1 per cent. of the present population.

The contingents furnished are divided into three classes:—

1st. The Principal Contingent.
2nd. The Reserve Contingent.
3rd. The "Ersatz" Contingent.

This latter forms the depôts from which the casualties in the other two contingents are to be replaced.

The principal and reserve contingents are always to be maintained in such a state of efficiency as to be ready to take the field in full strength

within five weeks after receiving their orders. Efficient provision must also be made for embodying the "Ersatz."

The laws passed in 1821 and 1822 fix the relative proportions of the various arms as follows:—

One-eighth of the total strength to be cavalry, one-hundredth to consist of pioneers and engineers, and the proportion of artillery one gun for every 400 men.

The Federal siege-train to consist of 100 guns, 30 howitzers, and 70 mortars. Each *corps-d'armée* to have a pontoon train for a bridge 400 feet long, besides smaller pontoon equipments for divisions.

The total forces ought to number 503,000 men of all arms; but the numbers at present forthcoming are considerably larger: the inspection returns of 1858 showed no fewer than 560,000 effectives.

The Federal grand army is divided into nine separate *corps-d'armée*, each of which is from 40,000 to 60,000 strong, besides a division of reserve infantry.

The 1st, 2nd, and 3rd of these are furnished by Austria, and number 158,037 men.

Prussia gives the 4th, 5th, and 6th, with a total of 133,769 men.

The 7th is supplied by Bavaria, and is 59,334 strong.

The 8th by Wurtemberg, Baden, and Hesse Darmstadt, and includes 50,251.

Saxony, Hesse Cassel, Nassau, Limberg, and Luxemburg furnish the 9th, which numbers 38,281.

And the 10th consists of the contingents of Hanover, Brunswick, and seven smaller states, and has a strength of 45,746.

The reserve infantry division is made up by fifteen of the minor states; its force is 17,656, and it is destined to furnish garrisons for the Federal fortresses during war.

I shall not attempt to recapitulate the strength and composition of the contingents required from the various states individually, but I may mention that each has to contribute a division, brigade, battalion, or even a single company, according to its size and population. The separate fractions of the force thus set on foot are in all cases complete with cavalry, artillery, engineers, pontooners, train, commissariat, field bakeries, hospital equipment and attendants, &c.

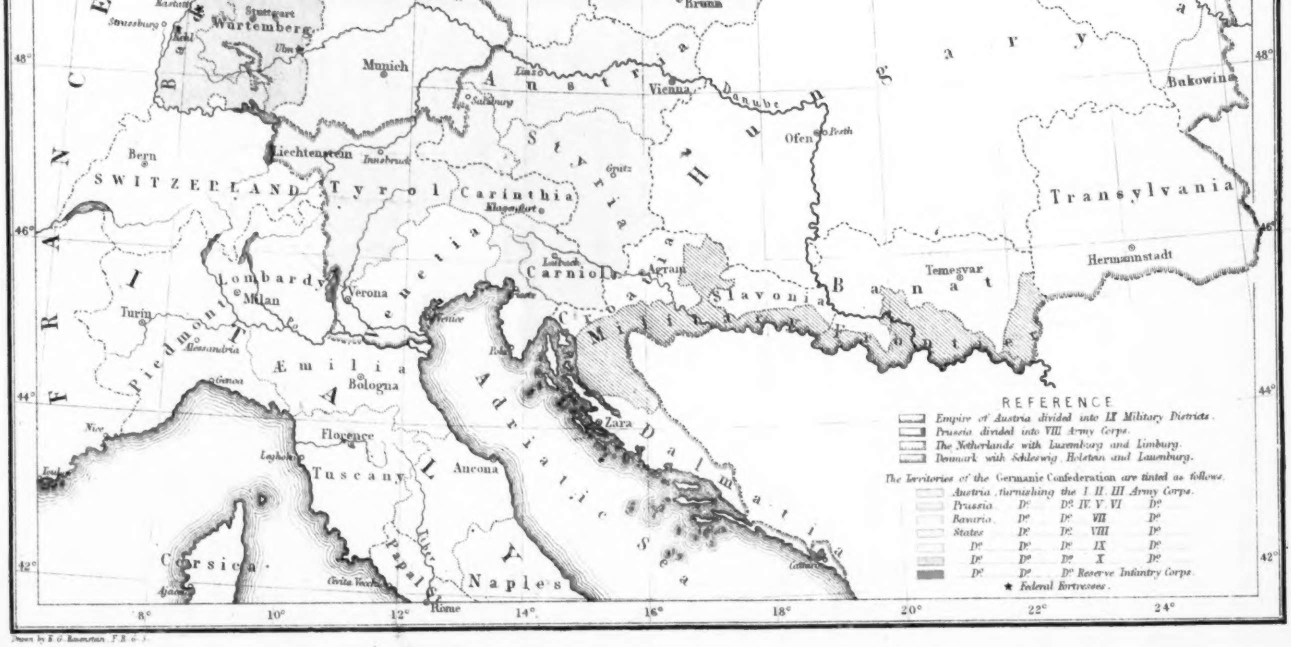
The contingents of contiguous states are frequently united in the autumn to practice manœuvring on a large scale, and the various divisions of the forces are inspected annually.

With the view of rendering these inspections as impartial as possible, the general, or other superior officer, always belongs to a different state: thus, the Austrian forces would be inspected by a Prussian or Bavarian general, and the same principle is observed throughout.

I have thus endeavoured to give a brief outline of the military constitution of this rather cumbrous and complicated confederation, which, no doubt, looks very perfect on paper; but it is needless to say that its effectiveness in time of emergency must entirely depend upon the cohesion and unanimity prevailing among its component parts.

In practice, its organization presents many anomalies: for example, no state has, or should have, a right to employ any Federal troops, or indeed


MILITARY MAP
OF
CENTRAL EUROPE,
To illustrate a Paper by
Captn. M. PETRIE, 14th Regt.
1861.
German Ocean
Heligoland
DENMARK
SWEDEN
Copenhagen
Schleswig
Holstein
Baltic Sea
Königsberg
Danzig
Prussia
Pomerania
Mecklenburg
Schwerin
Stettin
Hamburg
Oldenburg
Hanover
Brandenburg
Berlin
Magdeburg
NETHERLANDS
Amsterdam
Münster
Westphalia
Limburg
Cologne
Rhenish Prov.
Coblenz
BELGIUM
Luxemburg
Hesse Cassel
Nassau
Frankfurt
Saxony
Dresden
Thuringia
Posen
Bromberg
Vistula
Warsaw
RUSSIAN EMPIRE
Silesia
Glogau
Breslau
Neisse
Prague
Bohemia
Moravia
Brünn
Galicia
Krakau
Lemberg
Bavaria
Munich
Würtemberg
Stuttgart
Ulm
Landau
Rastatt
Strassburg
Kehl
Austria
Vienna
Linz
Danube
Hungary
Bukowina
II
III
IV
VI
VII
VIII
6°
8°
10°
12°
14°
16°
18°
20°
22°
24°
26°
54°
52°
50°
48°


REFERENCE
Empire of Austria divided into IX Military Districts.
Prussia divided into VIII Army Corps.
The Netherlands with Luxemburg and Limburg.
Denmark with Schleswig, Holstein and Lauenburg.
The Territories of the Germanic Confederation are tinted as follows.
Austria, furnishing the I. II. III Army Corps.
Prussia. D° D° IV. V. VI D°
Bavaria. D° D° VII D°
States D° D° VIII D°
D° D° D° IX D°
D° D° D° X D°
D° D° D° Reserve Infantry Corps.
★ Federal Fortresses.
Hungary
Transylvania
Bukowina
Austria
Styria
Carinthia
Carniola
Tyrol
SWITZERLAND
Wurtemberg
Venetia
Lombardy
Piedmont
Æmilia
Tuscany
Papal St.
Naples
ITALY
FRANCE
Croatia
Slavonia
Military Frontier
Banat
Dalmatia
Adriatic Sea
Corsica
Vienna
Munich
Ofen
Pesth
Danube
Gratz
Agram
Temesvar
Hermannstadt
Bern
Turin
Milan
Verona
Venice
Bologna
Florence
Ancona
Rome
Zara
Salzburg
Innsbruck
Linz
Liechtenstein
Ulm
Stuttgart
Strassburg
Kehl
Alessandria
Genoa
Nice
Leghorn
Cattaro
Brunn
8° 10° 12° 14° 16° 18° 20° 22° 24°
42° 44° 46° 48°
Drawn by E. G. Ravenstein, F.R.G.S.

any troops recruited upon Federal territory, in a war carried on by itself independently. Yet in the campaign of 1859 Austria collected almost all her German forces in Italy, garrisoning the Federal provinces with Hungarians, Croats, and Italians. This proceeding was not then objected to, it being considered that the contest was indirectly in the cause of Germany as a whole.

I may perhaps observe, that in one of the semi-official pamphlets which lately appeared in Paris, it was laid down as a principle, that if Germany generally were to acquire the consistency of a single power, France would consider it necessary to place the Rhine between herself and it, in order to provide security against so formidable a neighbour; but that at present the martial array of Germany might be regarded as rather a harmless affair than otherwise.

Austria.

The empire of Austria extends over an area of 257,000 square statute miles, and has a population of 35,000,000. This is of course exclusive of Lombardy.

I have already stated that Austria furnishes three *corps-d'armée*, amounting to 158,037 men, to the Germanic Confederation. This is, however, but a small fraction of the numbers that can be brought into the field in case of war, for they amount to nearly 740,000 men of all arms.

The Austrian army is recruited by the conscription, to which every province of the empire is subject. Exemptions are however granted, in favour of all ecclesiastics and students of theology, government employés, graduates of universities, and holders of entailed estates, besides others who can prove their presence to be necessary for the support of their families.

The conscripts are summoned to the ranks on attaining the age of twenty; they are required to serve eight years with the active army, and then for two years with the reserve.

The government engages to procure substitutes for a sum varying from £40 to £150; but it should be remarked that this bounty is only paid to the substitute on the termination of his engagement; the interest at 5 per cent. is, however, added to his pay while serving.

The war establishment of the Austrian army, according to the organization that came into force in April, 1860, is as follows:—

	Men.	Guns.
309 Battalions of Infantry - - - -	437,964	
41 Regiments of Cavalry - - - -	60,110	
136 Batteries of Artillery - - - -	27,176	— 1,088
2 Regiments Engineers - - - -	7,460	
6 „ Pioneers - - - -	6,858	
24 Squadrons Train - - - -	18,204	
10 Companies Sanitary Corps - - -	2,550	
Staff Corps, Corps of Adjutants and General Staff - - - - - - - -	3,889	
Total Regular Army - - -	564,211	

Brought forward -	- 564,211
Volunteer Corps organized in 1859 -	- 30,000
Depôts and Reserves of all Arms -	- 103,751
Gendarmerie, Police, Veterans, &c. -	- 40,382
Grand Total of Forces -	- 738,344

Among the 309 battalions of infantry are 29 of grenzers or frontier troops. These belong to the districts of Croatia, Slavonia, and the Banat, which border on Turkey. The inhabitants receive allotments of land from the government, and have to render military service in lieu of rent. The land itself belongs to the communes, who cannot sell or otherwise alienate it.

Each district containing 70,000 inhabitants, is obliged to contribute a regiment, every male inhabitant being liable to serve on attaining the age of twenty years.

During peace, the frontier troops are required to perform the local and police duties of their district, and receive no pay.

In case of war the whole force may be called out for service in the field, when they are placed upon the same footing as regards pay, &c. with regiments of the line.

The various nations composing the Austrian empire are represented in the army in the following proportion:—Germans, 26; Chechians, 19½; Ruthenes, 10; Poles, 7½; Croats, 5½; Slovenes, 4⅓; Servians, 4; Italians, 11½; Rumanians, 4¼; Hungarians, 6½; Jews and Gypsies ¾ per cent.

The ratio in which they exist in the general population of the empire is as follows:—Germans, 21·7; Chechians, 16; Ruthenes, 8; Poles, 5·6; Servians, 3·9; Croats, 3·6; Slovenes, 3·2; Italians, 15·2; Rumanians 6·6; Hungarians, 13·3; Jews, 2·6; Gipsies, 0·2; Greeks, Albanians, &c. 0·1 per cent.

Prussia.

After Austria, the most considerable of German powers is Prussia, whose somewhat scattered territories extend from the Niemen to the frontiers of France, and embrace an area of 108,376 square statute miles.

The population is 17,202,000, or about half that of the Austrian Empire, but the army that can be set on foot in case of war is nearly as numerous as that of the latter country.

The Prussian army is recruited by the conscription, to which every male subject becomes liable on completing his twentieth year. Exemptions are only granted to the clergy, and to others whose family circumstances require them to remain at their homes.*

Recruits have to serve for three years in the standing army, out of which however, they are generally allowed to go on furlough during the last year. They then belong for three years to the War reserve. This is only called out in the event of the army being mobilized, to raise the regiments to their full strength. Having thus belonged to the regular army for

* Young men of respectability and education are allowed the option of joining the army as "Freiwilliger," or Volunteers, who serve for one year only, but receive no pay or rations. They usually afterwards pass an examination as Landwehr officers.

six years, soldiers pass into the 1st ban of the "landwehr" for seven years, and from that to the 2nd ban for a similar period.

The 1st ban of the landwehr is called out in case of war, and joins the regular army in the field. During peace, the men meet twice in each year, at what are termed control meetings. Every second year they are assembled for a fortnight's drill, and every four years they have to assist at manœuvres on a large scale for a month.

The 2nd Ban of the landwehr are not assembled for training in time of peace. If called out during war, they would principally serve as garrison troops.

As every Prussian regiment is raised in a particular district, the landwehr regiments are composed of men who have already been accustomed to act together, and they are fully as efficient as those of the regular army.

In case of any great emergency, the "landsturm," consisting of all men from 17 to 50 years of age, may be called out; but this force has at present no organization.

The War Establishment of the Prussian army is as follows:—

	Men.		Guns.
Infantry.—Guard, 9 Regiments - -	28,674		
Line, 72 Regiments - -	229,392		
Jäger, 10 Battalions - -	10,480		
Total - - -	268,546		
Cavalry.—48 Regiments - - -	36,768		
Feld Jäger and Staff Orderlies	902		
Total - - -	37,670		
Artillery.—9 Regiments - - -	41,292		1,228
Pioneers, Train, &c. - - - -	11,971		
Total Field Troops -		359,479	
Depôts and Ersatz Troops - - - -		98,487	216
Landwehr and Garrison Troops, &c. - -		261,126	
Grand Total of Forces - -		719,092	1,440

Last year the Prussian government wished to modify the laws on military service, so as to secure a fuller control over the army—to make it, in fact, more royal and less national. With this view a bill was presented to the Legislature, extending the term of service in the regular army to eight years, of which three were to be passed with their regiments by the infantry and artillery, and four by the cavalry; and the term of service in the landwehr to be reduced to eleven years. This bill was amended in committee, and subsequently withdrawn, but its provisions have notwithstanding been acted upon to a great extent.

The landwehr element has never been very much to the taste of the Prussian government, as the men have often shown a strong disposition to have their own opinions, when called upon to act. When employed against the insurgents at Baden Baden in 1848, they manifested so much hesitation in attacking the revolutionary troops, that it was needful to

stimulate their zeal by the sight of a battery of artillery drawn up in their rear, and ready to open its fire upon them.

The forces of the thirty-four remaining states of Germany must be considered to possess a collective, rather than an individual importance, as they are all units in the Confederation, and not one of them could make war without the sanction of the central authority. In fact, we may regard Austria as the only German power that can bring an army into the field, and undertake a war, on her own account. And even this is doubtful; for had the war in 1859 been prolonged, the rest of Germany must have been drawn into the contest; a fact which was in no small degree instrumental in bringing about the peace of Villafranca. As it was, Trieste and the adjacent coast, being Federal property, could not be blockaded by the allied fleets, nor could Verona be besieged, without much embarassment, for the Confederation boundary line runs within a short distance, and any Austrian force acting against the besiegers would have found a safe sanctuary within it, issuing and retiring again as they pleased.

With regard to Prussia, though her forces are numerically very strong, yet I think we can hardly avoid the conclusion that they should only be viewed as an integral fraction of the German army. Her geographical position and political sympathies, would hardly admit of her undertaking any military operations, in which it was considered that the interests of the Fatherland generally were not involved. In the present difference with Denmark, Prussia is only acting as the representative of the other German states, whose troops would join hers in the event of hostilities against Holstein.

It is true that Prussia threatened to go to war with Switzerland about the Neufchâtel question in 1847. The order for the mobilization of the army was in fact signed by the king, and was to have been issued the next morning; but the arrival of a telegraphic despatch from Berne, announcing that the Diet ceded the points demanded, prevented the decree from being put in force. Now, the king had declared that military operations would take their course if the army were once mobilized; yet I am inclined to think that the threat was rather an empty one, as a glance at the map will show that half a dozen intervening duchies must have been traversed, before the Swiss frontiers could be reached, and the sovereigns of these were not at all favourable to the Neufchâtel crusade, and would hardly have given their consent. In fact, Prussia was after all obliged practically to abandon the ground she at first took up.

Russia.

Russia, as you are aware, is the largest of the countries of Europe, containing an area of 8,325,311 square statute miles, which is five times the superficies of the rest of Europe put together.

The census taken after the late war showed the population to number 68,931,728; of these 900,000 belonged to the nobility or privileged classes, 53,426,216 citizens, and 21,000,000 serfs.

The Russian army is the most numerous and most complicated in its organization of any in Europe.

The aggregate numbers of the Russian forces have varied considerably within the last few years. Before the war, the imperial muster-rolls contained 1,140,000 men of all arms; in 1855 the number approached 2,000,000; but it has since been much reduced, and the present strength is about 850,000.

The army consists of the following principal divisions:—

The Active Army.
The Reserve.
Garrison Troops.
Irregular Troops, composed principally of local corps of Cossacks.

The Russian regular army is recruited by conscription, and there are three general recruiting divisions.

1st. The Polish provinces.

2nd. The western zone of the empire, including Lithuania, Volhynia, Podolia, Kharkov, Little Russia, and the Baltic provinces.

3rd. The eastern zone, embracing the rest of the empire, as far as Khamschatka.

In Poland every able-bodied inhabitant between the ages of twenty and thirty may be taken as a soldier, and no exemptions are granted to the nobility; a special tax is levied for conveying the recruits to the depôts.

In the rest of the empire, the landed proprietors have to furnish recruits from among their serfs, to send them to their depôts at their own expense, besides paying £12 towards the outfit of each.

The regular active army of Russia is organized as follows:—

1st. The Corps of the Imperial Guard.
2nd. The Corps of Grenadiers.
3rd. The six Permanent *Corps d'Armée.*

The corps of the Imperial Guard in the present peace establishment, consists of—

3 Divisions of Infantry.
2 „ Cavalry.
3 Brigades of Artillery.
1 Battalion of Sappers.

Each infantry division consists of 2 brigades, and 1 battalion of rifles. Each brigade is composed of 2 regiments.

A cavalry division contains 3 brigades of 3 regiments each. Each brigade of artillery consists of 2 batteries of 8 guns each.

The total strength of the Imperial Guard, as thus constituted, is 41,845 men, and 48 guns.

The corps of Grenadiers is also made up of infantry, cavalry, artillery, sappers, &c., and numbers 30,321 men, with 60 guns.

Each of the 6 *corps d'armée* consists of—

3 Infantry Divisions.
1 Cavalry „
1 Artillery „

Every infantry division comprises 2 brigades of 4 regiments each, besides a battalion of rifles.

A cavalry division consists of 3 brigades of 2 regiments each. The first of these is invariably a dragoon brigade. The second a lancer brigade, and the third a hussar brigade.

The artillery division consists of—

1 Horse Artillery Brigade of	2 batteries.
3 Foot " "	4 batteries each.
1 Park brigade of	3 batteries.

A *corps d'armée* thus composed should have a total establishment of nearly 50,000 men and 84 guns, but the strength of the regiments and squadrons has lately been so much reduced, that each corps does not bear more than 20,000 effectives upon its rolls.

The war establishment of the whole active army, formed of the eight *corps d'armée*, is 520,523 men, and 1,160 guns.

The garrison troops of Russia form a separate *corps d'armée*. They are all infantry, and are composed of men not physically fit for the rank and file of the active forces. They furnish garrisons to various towns and posts, guards for public establishments, and do escort duty for short distances ; their total number is about 100,000.

The general distribution of the Russian regular army is as follows :—

The corps of the Guard is stationed in and around St. Petersburg.

The corps of Grenadiers at Moscow, Vladimir, and Riazan, in the centre of European Russia.

The 1st, 2nd, and 3d *corps d'armée* are stationed along the western frontier.

The 4th and 5th in Volhynia, Podolia, and Bessarabia.

The 6th along the Volga, on the confines of Siberia, so as to be equally ready to act either in the Caucasus, or in Central Asia. One division of this corps is at present serving in the army of the Caucasus.

As the active army of Russia is destined to deal with the forces of the various European powers, there is a vast array of irregular or rather local forces organized for service in the interior, but especially on the eastern and southern frontiers. In these all three arms of the service are represented, but the cavalry is generally the preponderating force.

The Russian irregular troops may be divided into two distinct branches.

1st. The Cossacks of the Don, composed of fifty-seven regiments of cavalry, in addition to a regiment of cavalry and a battery of artillery, attached to the Imperial Guard at St. Petersburg.

The other branch consists of the whole of the rest of the irregular corps, with the exception of the Cossacks of Azov.*

Many of these irregular corps, which extend across the Russian empire from the Chinese frontier to the Black Sea, are formed into *corps d'armée* for service in Asia.

* The Cossacks of Azov are borne upon the muster rolls as a corps of cavalry, but in reality they are marine artillery, for service in the Black Sea. As the treaty of Paris forbids any naval forces being maintained there, they are at present doing duty on board of the vessels of the Odessa Steam Navigation Company.

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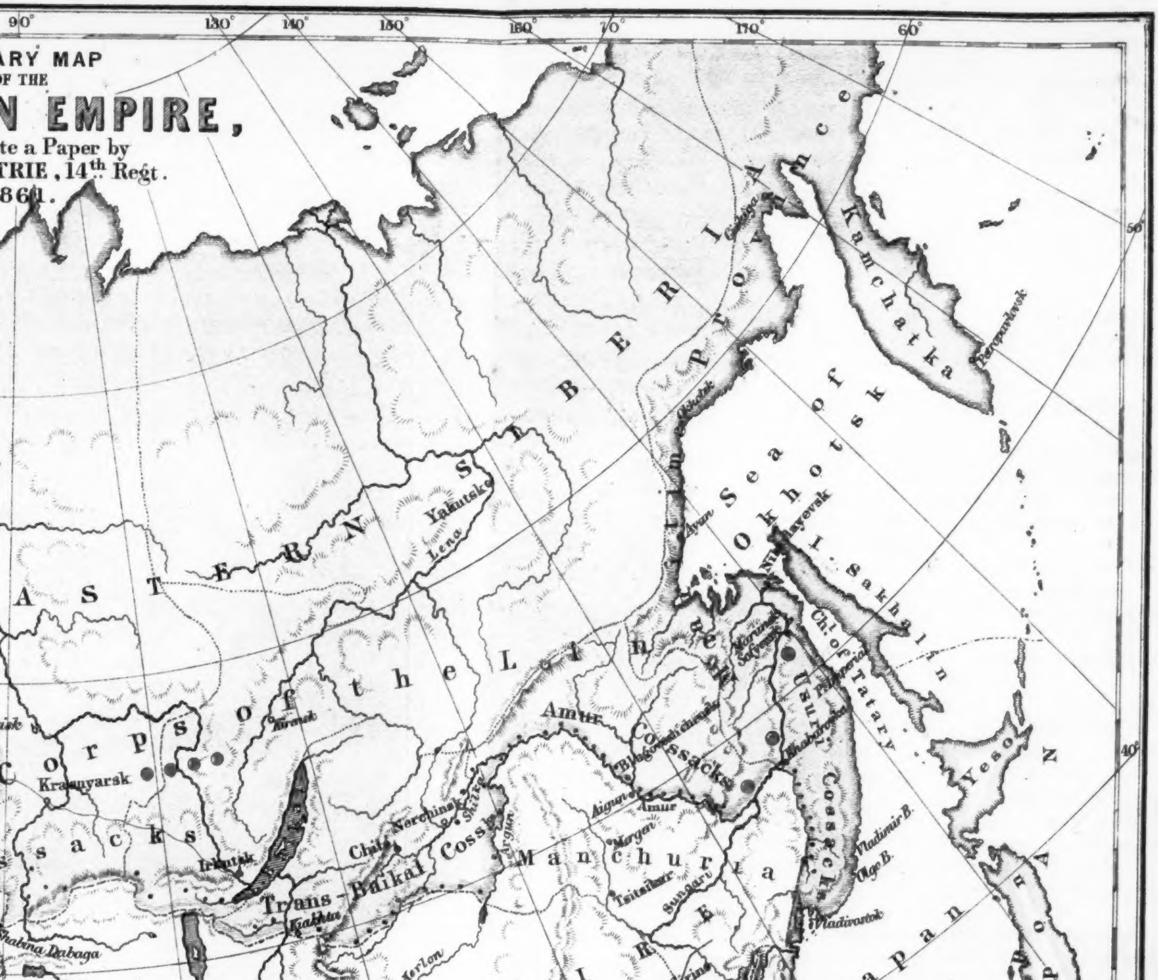
Lith. & Drawn by E.G. Ravenstein, F.R.G.S.


ARY MAP
OF THE
N EMPIRE,
te a Paper by
TRIE, 14th Regt.
1861.
S I B E R I A
E A S T E R N
Corps of the Lithuania
Trans-Baikal Cossacks
Amur Cossacks
Usuri Cossacks
Kamchatka
Petropavlovsk
Sea of Okhotsk
Okhotsk
Ayan
Nikolayevsk
I. Sakhalin
Ch. of Tatary
Yakutsk
Lena
Krasnoyarsk
Irkutsk
Kiakhta
Chita
Nerchinsk
Shilka
Argun
Amur
Aigun
Blagoveschensk
Khabarovka
Mariinsk
Sofyevsk
Imperial
Vladimir B.
Olga B.
Vladivostok
Manchuria
Merghen
Tsitsihar
Sungari
Girin
Mukden
Peking
Hanyang
KOREA
Urga
Kerlon
Khatina Dabaga
CHINESE EMPIRE
Sea of Japan
Yeso
NIPPON
Yedo
J A P A N
Reference.
The Provinces occupied by Local Corps are tinted.
Battalion of a Local Corps of Infantry of the Line.
Battalion of Indelta (Distributed) troops in Finland.
Town with Garrison Battalion.
Cossack Village (Stanitsa) or Station.
Division of the 1st to 6th Army Corps.
Division of the Army of the Caucasus.
90°
130°
140°
150°
160°
170°
110°
60°
50°
40°
30°
100°
110°
120°
130°

We enumerate them as follows :—

Cossacks of the Don.
Cossacks of the Black Sea.
Cossacks of Azov.
Cossacks of Astrakhan.
Cossacks of Oremberg.
Cossacks of the Oural.
Cossacks of the Siberian Frontier.
Cossacks of the Trans-Baikal.

Their total force may be estimated at 150,000 men and 200 guns.

The army of the Caucasus is a permanent local army, and consists of four divisions of regular infantry, one of which belongs to the 6th *corps d'armée*, one division of grenadiers, one of cavalry, besides the irregular troops of the line of the Caucasus. Its strength is about 120,000 men with 200 guns.

The present advances of Russia in the direction of India and China are a source of no small concern to England ; it may be interesting, therefore, to take a view of the troops that are pushing their way to conquests in these regions, and steadily, though silently, spreading the mantle of the Russian empire over the independent tribes of Central Asia.

First, there is the corps of Oremberg, constituting a regular *corps d'armée*. The Russian returns give its strength thus :—

17 Battalions of Infantry - - -	18,511	
12 Regiments of Cossacks - - -	10,652	
3 Batteries Horse Artillery - -	774	— 24 Guns.

Its real strength, however, is probably much greater, as it was this corps that in 1853 reduced half of Tartary into subjection to Russia for the first time.

Secondly, there are the Cossacks of the Oural ; this corps occupies a central position between Europe and Asia, and can act as a support to the corps of Oremberg: the returns of it give about 8,800 men and horses.

The corps of the Siberian frontier furnishes a military cordon along the south of the Siberian territory. It consists of 9,584 men, composed of 10 regiments of cavalry and 24 guns.

But the most important of the Russian Asiatic corps is that of Trans-Baikal,* occupying the district through which the Amoor river runs.

Though one-third of the circumference of the globe separates this province from St. Petersburg, we nevertheless find the Northern Colossus in full activity, and within the last few years the Russian frontier has advanced southwards along the western coast of the Sea of Japan, to the extent of not less than 600 miles. In the present condition of the Celestial Empire, we should not be surprised if the double-headed eagle, ere long, supplants the dragon in the Yellow Sea.

The Trans-Baikalian corps is a new creation, and its organization has been pushed with great activity within the last few years. Its present

* So called from its position beyond the lake Baikal.

strength would enable operations to be undertaken against China with ease. It is composed of infantry and cavalry only—the want of roads, and the enormous distance from Europe, forbidding the creation of artillery.

It numbers at present 17,000 men, but is to be raised to 30,000.

We thus see three distinct armies progressing eastwards and southwards ; doubtless in the hope of one day securing the command of the western shores of the Pacific, on the one hand, and on the other, of threading their way through the defiles of the Hindoo Koosh, and debouching eventually upon the plains of Hindostan.

Until the year 1854, the actual state of the Russian forces was a species of enigma. We heard of a fabulous array of regular troops, and endless tribes of Cossacks; but it was hinted that this army existed chiefly on paper, and a distinguished statesman talked very comfortably of "crumpling up" Russia. Upon trial, however, the "crumpling up" process was found to lacerate our own hands not a little, and the Russian troops showed a discipline and a constancy for which few had given them credit.

Last year the Russian government published for the first time a detailed statement of the cost and strength of their military establishments.

This document shows that every effort is being made to augment the efficiency, and to raise the character and *morale* of their soldiers.

The military colonies have been abolished, and the laws that constituted military service a punishment for various crimes have been abrogated. The sons of soldiers, borne on the rolls as "*fils de troupe*," and who number 578,000, have been exempted from entering the army. The pay has been increased, and a scale of pensions established. Regimental schools and *gymnasia* have been organized, and a variety of other useful measures of reform adopted.

The arms also have been improved, rifles have been largely introduced throughout the service, and schools of musketry established.

The artillery likewise is being furnished with rifled guns.

Italy.

Only two years since, Italy was a geographical expression, and consisted of eight separate states, viz. the Two Sicilies, Sardinia, Tuscany, the Papal States, Parma, Modena, the Principality of Monaco, and the Republic of San Marino.

The united war establishments of the armies of these amounted to 305,000 men, of which the Two Sicilies furnished 143,000, Sardinia 112,000. The forces of San Marino were just 40 men.

At the present moment the Italian national banner waves over the whole Peninsula, from the Alps to Cape Passaro, with the exception of Venetia and the Roman territory held by French troops. Upon Victor Emmanuel will devolve the undertaking of organizing the Italians, already united by the ties of "blood, language, and religion," into a single nation. In this task does not nearly every Englishman heartily bid him "God speed?"

The Sardinian army as it existed in 1858 could place, as I have said, 112,000 men in the field. This force was recruited by conscription, which extended to the insular portion of the kingdom, and to which all classes

were liable, irrespective of rank, excepting a limited number of students for holy orders. Exemptions on account of family circumstances were, however, granted on a liberal scale, and exoneration from serving was permitted to be purchased for £120. The number of males annually attaining their twentieth year was 52,000; of these 34,000 were excused, or were physically unfit, leaving an available contingent of 18,000 men.

This contingent was divided into two classes, or categories. The first, consisting of those who had drawn low numbers, joined the standing army, in which they served for five years, and were then allowed unlimited furlough for six years, after which their military liabilities ceased. The second class were only called out for training during forty-two days in each year, and were free after five years. In case of war, those of the first class on furlough, and the whole of the second class, were called out, to place the regiments and squadrons on a war footing.

It is now intended to apply the conscription to the whole peninsula; and calculating from the numerical returns of the population, the Italian forces ought eventually to show a muster of not less than 600,000. At present, however, as the armies of the late princes have been disbanded, and there are no classes of previous years available over a large portion of the peninsula, we cannot reckon upon a strength of more than 400,000. Considerable difficulties will lie in the way of carrying the conscription into effect over the whole of Italy and Sicily, as neither the latter island nor the Papal States have hitherto been subjected to it under their late governments; and its enforcement in these provinces will in all probability cause considerable excitement and opposition.

Possibly it will amuse you to learn a reply given by the Pope to General Lamoricière, when the latter told him he never could hope to raise an adequate army without resorting to compulsory service; he said that he had conscientious scruples on the subject, not considering it right to impose celibacy on any one. You are aware that abroad permission for soldiers to marry is a rare privilege. The inconsistency of the statement, as proceeding from his Holiness, hardly requires comment.

With regard to the efficiency of the future army of Italy, doubts may be entertained whether it will be as good as the type from which it takes its origin. The campaign in the Crimea showed the excellent spirit and organization of the Sardinian troops, and Lombardy and Romagna will no doubt furnish equally good material. The Tuscans, however, are too soft and effeminate to make very brilliant soldiers, and the change for the worse becomes greater as we proceed southwards, the army of the Two Sicilies never having been supposed to possess any military qualities worth mentioning. Apropos of this, I will relate an anecdote of King Francis the First. When he was on one occasion complimented on the martial bearing and soldierlike appearance of his troops at a review, he dryly replied, with a shrug of his shoulders, "Si, leoni in citta, ma lepri in campagna." On another occasion, when a proposition was made to him to have the breasts of the soldiers' coats quilted with cotton, in order to enable them to resist sword-cuts the more effectually, his answer was, that *he* would suggest the quilting should be applied to their backs, as they were the part invariably presented in action to the enemy.

Let us hope, nevertheless, that a just and equable administration, and a

consciousness of the cause in which they bear arms, being that of their newly enfranchised nation, and not of an unprincipled and arbitrary despot, will inspire them with zeal to emulate the deeds of their more northern brethren.

France.

Perhaps of all the European armies the one which possesses the highest interest for England is that of France.

Including Savoy and Nice, but exclusive of Algeria, the empire contains 212,893 square statute miles, and had a population in 1856 of 36,877,800.

The army that can be put on foot in case of war, numbers about 626,000, besides 10,000 local and colonial troops and 6,550 marines kept in the French possessions abroad.

The French army is chiefly recruited by conscription, the contingent required being fixed annually by imperial decree, and the proportion to be furnished by each canton is regulated by the numbers inscribed upon the "Listes du Tirage" as having completed their twenty-first year within the preceding twelve months.

In 1855 the contingent was fixed at 140,000 men. The total number inscribed was 306,622, which were accounted for in the following manner:—

		Per Cent.
Exempted on account of family circumstances	42,457	13·85
Rejected on account of being under the standard height of 5 feet 1 inch	17,951	5·85
Rejected on account of being physically unfit for the service	62,564	20·40
Liberated unconditionally, being over the number required	45,974	15·00
Included in contingent	137,676	44·90
	306,622	100·00

The deficiency was caused by the fact that several of the cantons were unable to furnish the number assigned to them. Out of the 137,676, 20,239 were deducted as having already joined the army or the navy; and 2,768, being students for holy orders, &c. were *dispensés*. 1,387 were allowed to remain at home as the sole support of their families; 257 were struck off on account of deaths, errors, &c.; 525 were found unfit after joining; 2,016 absented themselves, and were declared refractory "*insoumis*"; and 5,100 were incorporated into the navy.

The total number of new recruits actually available was thus reduced to 105,388.

It is worthy of remark, that in 1858 the number inscribed was only 305,943. Conscripts living within the same canton and belonging to the same class may exchange tickets: this is termed "substitution," and the number who availed themselves of it was 718. A conscript may also be "replaced" by a relative, but the *remplacent* must not be over 30 years of age, or 35 if he has previously served in the army.

There were 16,173 cases of *remplacement* in 1855.

Exoneration from serving may be purchased by the payment of about 92*l.* into the Caisse de la Dotation de l'Armée. The fund is employed in

granting bounties and extra pay as an inducement to volunteer, or to re-inlist into the army.

The following classes are thus eligible for admission :—

Volunteers after four years' service, conscripts within one year of being unconditionally liberated, and others who have completed their term of service. These receive a bounty of 40*l.* on first joining, and a similar sum on completing their engagement of seven years, besides 1*d.* a day extra pay while serving.

The number of these *engagés* and *rengagés* in 1855 was 16,676, in 1858 21,955.

The term of service in the French army is seven years, of which, however, not above four are usually passed with the regiments.

The Imperial Guard is recruited by soldiers who have served meritoriously in the line for at least two years.* The Zouaves, Turcos, Chasseurs d'Afrique, Spahis, and Foreign Legion are recruited by voluntary enlistment.

The ordinary annual contingent in time of peace is 100,000 men. This is estimated to give an effective augmentation to the army of about 85,000.

Prior to 1860 the price of exoneration was only 80*l.* It was raised to 92*l.* in consequence of the large and annually increasing number of conscripts who purchased exemption from serving. These in the year previous amounted to 38,323, or 27 per cent. In 1858 the proportion was 18 per cent., and in 1856 and 1857 only 16 per cent.

The standard heights for the different branches of the service were fixed by an Imperial decree of the 13th April, 1860, to be as follows :— Cuirassiers, minimum, 5 feet 8 inches ; dragoons and lancers, 5 feet 6·5 inches to 5 feet 8·4 inches ; artillery, minimum, 5 feet 6·5 inches ; chasseurs and hussars, 5 feet 5·3 inches to 5 feet 7·8 inches ; infantry of the line, chasseurs à pied, &c. minimum, 5 feet 1·4 inch.

In enumerating the French army, we may commence with the squadron of the Cent Gardes, numbering 221, with 179 horses : these form the Imperial escort on all occasions. The splendour of their appearance is only equalled by the thorough efficiency of their arms and equipment. Every man carries a breech-loading rifle that has an effective range of 1200 yards, and a long, straight, double-edged sword. The latter is constructed so as to fix to the end of the rifle, and thus form a lance.

The Imperial Guard forms a complete *corps d'armée* in itself. It is composed as follows :—

1 Regiment Gendarmerie.
7 ,, Grenadiers and Voltigeurs.
1 ,, Chasseurs.
1 Squadron Gendarmerie à Cheval.
6 Regiments Cavalry.
15 Batteries of Artillery.
2 Companies of Pontooneers.
2 ,, Engineers.
4 ,, Train.

Its total establishment is 38,060 men, 13,447 horses, and 90 guns.

* A decree of the 27th April, 1860, authorises men who have not served to be received into the Imperial Guard, provided their character and physical qualities are satisfactory.

The Infantry consists of—

103 Regiments of the line, each having 3 active battalions, and 1 depôt battalion.
20 Battalions Chasseurs.
3 Regiments Zouaves.
2 „ Foreign Infantry.
3 Battalions of African Light Infantry.
3 Regiments of Turcos, or Tirailleurs Algériens.

The Foreign Infantry, African Light Infantry, and Turcos are generally stationed in Algeria.

The first of these are recruited by voluntary enrolment, and are composed of stray individuals from every country in Europe, questions as to character not being asked.

The African Light Infantry is a disciplinary corps, and receives into its ranks such soldiers as incur a punishment involving more than three months' imprisonment: by subsequent good conduct, however, they may entitle themselves to be retransferred into their original regiments. Any man misconducting himself whilst in the African Light Infantry, renders himself liable to be sent into the "compagnies disciplinaires" of the colonies, stationed in the West Indies, Senegal, the Island of Réunion, and Oceania.

The Turcos, or Tirailleurs Algériens, are recruited by voluntary enlistment. The officers, and most of the non-commissioned officers, are French, the men being natives of Algeria. They took part in the Italian campaign of 1859, but showed so turbulent a disposition in the march from Genoa, that it was found necessary to take the ammunition from their pouches. At Solferino they robbed the packs of a regiment that had taken them off in order to make a charge, and I suppose a collection of greater ruffians could hardly be met with anywhere.

The French Cavalry numbers 58 regiments, and is 70,000 strong. It is divided into light, line, and heavy. The latter wear the cuirass; but it is, I believe, contemplated to make the whole of the French cavalry Light, and to arm every man with a rifle of long range.

In noticing this arm of the service, I should not omit the three regiments of Spahis, who are, with the exception of the officers, natives of Algeria, and are equipped in the Arab fashion. The saddles have backs as high and commodious as an easy chair; their arms consist of a sword secured under the left saddle flap, and a long rifle slung across their back. They are, of course, innocent of the *tracasserie* of a European soldier's kit, and as they ride along, enveloped in the folds of an ample red cloak, look not unlike Welch women going to market.

The French Artillery is composed as follows:—

4	Regiments	Horse Artillery,	with	192	guns.
10	„	Mounted „	„	600	„
10	Batteries	Foot „	„	60	„
1	Regiment	Pontooneers.			
6	Squadrons	Train.			

Giving a total of 38,767 men, 37,954 horses, and 852 guns—this, is in

addition to 15,000 garrison Artillery, and the depôts, artificers, &c.—so that the total number of guns that can be brought into the field, including the Imperial Guard, is 942.

The guns are of brass, and are all rifled ; every exertion is being made to render the *matériel* as perfect as possible ; but I must add that the French say they consider their brass muzzle-loading guns, such as were used in Italy, more serviceable and effective than our Armstrongs—an opinion hardly endorsed on this side of the Channel.

Among the military powers of Europe we must unquestionably accord to France the first place. Her army, it is true, is numerically inferior to that of either Russia, Austria, Prussia, or the probable future army of Italy; but morally and practically she is almost, if not quite, a match for any two of them. The Russian forces are scattered over a vast area, and composed in a great measure of a labyrinth of tribes of Cossacks, who are, from their constitution, moveable only to a very small degree ; and the want of railway communication, and of even good roads, cause the concentration of any considerable force to be a work involving great time and labour, to say nothing of expense, always a very important item in military calculations. Austria, too, has a large army, and no pains have been spared by the government to make it as efficient as possible. But, on the other hand, it is composed of many nationalities, speaking different languages, and having in some instances no political sympathies with the Imperial Government. In proof of this, I may state that at Solferino several regiments of Croats marched off the ground in good order, refusing to draw a trigger against the allies. Prussia and Germany are, indeed, united in interests and sympathies, but they are divided into a number of fractions, each ruled over by its own petty prince. In case of war the authority of these must fade away, and that of the Federal power come to the front, ere the German forces could, as a united body, take the field.

In France none of these adverse conditions exist. Every Frenchman feels a pride in the consciousness of his nationality, the French language is nearly universal, her territories are compact, and traversed in every direction by a network of railways laid out so as carefully to meet every strategical contingency, and clusters of strong fortresses line the frontiers from the British Channel to the Mediterranean. Algeria, so profitless as a colonial possession, furnishes an excellent practical school of campaigning. The troops of all arms, which I had excellent opportunities of observing, when they were concentrated at the grand reviews held on the occasion of the Emperor's visit to his African dominions last September, had a highly soldierlike and serviceable appearance. The French superior officers are practised in handling troops in large masses, and the men themselves are taught to be constantly ready to move at the shortest notice, every man having his *tente d'abri*, his cooking utensils, and camp equipment, as part of his kit, and he never appears on parade without them.

The events of the spring of 1859 may serve as an example of the extraordinary rapidity with which a French army can be assembled, and directed upon any given point. Then we saw how, with scarcely any warning, with hardly a single note of preparation, 200,000 men, armed and equipped with every modern appliance, were poured into the plains of Lombardy. Even this performance, however, did not satisfy the French

Emperor; for at that time, in spite of all precautions, the collection of clothing, fuel, and warlike stores, in the French magazines, and the activity prevailing in the arsenals, could not be concealed. The *Moniteur*, we know, inserted the most laboured articles to prove that the "apparent movement" was only due to the fact of the stores having fallen rather below their usual level, and its columns vented violent invectives against those who hinted that warlike preparations were in progress, which, supported by the Imperial speech on opening the Chambers, ought to have reassured all reasonable people ; but these efforts were not entirely successful. In order, therefore, to secure for France the utmost advantage in point of time on any future occasion, a decree was issued soon after the termination of the war, ordering the *intendance* to collect and to keep on hand such supplies of clothing, shoes, camp equipage, and every species of *matériel*, that the French army could be placed upon a war footing, and put in motion, without previously attracting notice at home or abroad.

I may, perhaps, be asked, What number of troops could France at present bring into the field ? The French official returns show that on the 1st of January, 1860, the number of available men was as follows:—

Troops in France - - - - - - -	398,559
" Algeria - - - - - - -	83,782
" North Italy - - - - - -	55,281
" Rome - - - - - - -	7,904
" China - - - - - - -	5,468
Total under Arms - -	550,994
Men on Congé - - - - - - -	64,471
Reserve - - - - - - - -	11,017
Grand Total - - -	626,482

In the event of a European war we may assume 150,000 to be required for garrisons, depôts, artificers, civil forces, &c. and 60,000 for Algeria. Thus, the actual number of men that could be brought into the field, would be in round numbers something over 400,000. These figures are, of course, exclusive of National Guards, or any extraordinary levies.

Great Britain.

The army of Great Britain is recruited entirely by voluntary enlistment, and the whole of the British troops composing it are enlisted in the United Kingdom, with the exception of the 100th Regiment of the line, lately raised in North America.

Our present establishment is as follows:—

	Men.	Horses.	Guns.
Regular Troops of all Arms - - - -	218,971	30,072	366
British Local and Colonial Troops - -	18,249	—	248
Foreign and Coloured Troops, chiefly in India - - - - - - - -	218,043	—	58
Military Police in India - - - - -	79,264	—	—
Grand Total - - - -	534,527		672

Of this force, however, only a very small fraction is in the United Kingdom. At the present moment the forces in England, Scotland, and Ireland are—

	Men.	Guns.
Infantry.—Guards, 7 Battalions	6,297	
„ Line, 35 „	33,105	
Total	39,402	
Cavalry.—Life and Horse Guards, 3 Regiments	1,311	
„ Dragoons, &c., 16 Regiments	10,560	
Total	11,871	
Artillery.—Horse, 6 Batteries	1,200	36
„ Field, 23 „	5,060	138
„ Garrison, 39 „	4,680	—
Total	10,940	174
Engineers	2,316	
Military Train	1,830	
Hospital Corps	609	
Commissariat Staff Corps	300	
Grand Total, Active Forces	67,268	174

Besides, there are the Depôt Establishments, as follows:—

Infantry, Line, 126 Depôts	24,770
Cavalry, „ 9 „	396
Artillery	2,975
Total Depôts	28,141

Reserves available for the defence of the kingdom in case of war:—

Pensioners	14,768
Militia	45,000
Yeomanry	16,080
Irish Constabulary	12,392
Volunteers	140,000
Total	228,240

A glance at these figures shows that our military establishments bear no proportion in point of numbers to those of the continental powers, and that our forces at home are no more than sufficient to furnish the necessary reliefs for our colonial garrisons. Of reserves of regular trained troops we have actually none, and when any emergency occurs, we can only fill up the ranks of our regiments with raw recruits, by the slow process of enlistment.

We may, perhaps, be disposed to envy the wonderful elasticity of the *personnel* possessed by the great military monarchs of Europe, the stroke of whose pens call up trained soldiers in round hundreds of thousands at a time; but when we come to analyse the cost at which this is achieved, the bill proves a heavy one, and do we not see more than one of the great European powers scarcely able to stand under the weight and burden of their military establishments? The limits of a lecture forbid me to enlarge upon this interesting and important branch of the subject, but I must nevertheless be permitted to remark that the sum total of the military and naval budgets, or the per-centage of the general revenue absorbed by them, afford but very imperfect data for drawing a parallel between the pressures actually entailed upon the resources of different countries, and it would be equally fallacious to divide the number of pounds expended in a year by the number of men kept up, and to take the results as any relative criterion of the economy of different administrative systems. It would be difficult to reduce to figures the actual commercial loss, and the drain upon the general prosperity of a nation, to say nothing of the social inconvenience that is entailed by the system of compulsory service—in fact we may take it as an axiom, that if, like Cadmus, we sow dragon's teeth, and regard the crop as one of our staples, we shall find it the most exhausting to the soil of any we can cultivate. The amount of desertion prevailing in the British Army is a favourite topic with French authors, when trying to disparage our military institution; they point contemptuously to our men, whom, they say, are only to be bribed to serve by a vicious system of bounties, and then turn round exultingly, telling us to look at France, where *all* embrace the noble career of arms, from the peer to the peasant! Well, so they do; not from choice, however, but because they cannot help themselves. They, too, would desert, but the police and gendarmerie are too sharp for them, and desertion is a game with edge-tools on the other side of the Channel.

I feel sure that I do not exaggerate when I say that the word "conscription" carries terror and dismay to every town, village, and homestead of the whole continent of Europe. So severely did it press on the French nation during the First Empire, that, though the salaried dependents of the Emperor voted all his demands for men most obsequiously, and the press were lavish in their encomiums on his measures, it was not without extreme difficulty and excessive rigour that the conscription could be carried into execution, particularly in the rural districts; and everybody was forced to serve, unless their bodily infirmities rendered them quite helpless.

Exemptions were at first allowed to be purchased for 300 francs, but this privilege was soon repealed, and in the latter days of the Empire a substitute could not be procured for less than £800 to £1,000.

Those who, after being drawn, failed to join the army within the prescribed time, were deprived of their civil rights, and denounced to all the gendarmerie in the empire as deserters. Depôts were appointed for the punishment of the refractory, where they wore the uniform of convicts, and were employed to labour on public roads without pay.

The terrors of this treatment being at length found insufficient to bring the conscripts to their colours, it was decreed that a deserter, or a person

who failed to attend, should be fined 1,500 francs, and condemned to three years' hard labour in the interior, with his head shaved, but the beard long. If he deserted from the army, his punishment was to be undergone in a frontier place, where he was sentenced to hard labour for ten years on bread and water, with a bullet of 8lbs. weight chained to his leg.

This was the merciless way in which the French army was recruited; nor can we wonder that such laws were required, when we find that in the ten years the Empire lasted, no less than 2,300,000 additional conscripts were enrolled, of which number 2,200,000 perished. In 1813 it was not an uncommon sight to witness gangs of conscripts being marched in chains to their depôts.

It will, of course, be said that I am resuscitating events of half a century since, and that in the present day the service in France is decidedly popular. Let the returns of 1859 speak for themselves. We find that in that year no fewer than 38,323 conscripts, or 27 per cent. of those drawn, paid 80*l.* each, to purchase exemption from serving; and, though the whole of this sum was paid to volunteers willing to engage for seven years, the number of the latter was only 16,372! The Minister of War, rather comically, sings a dirge in the columns of the *Moniteur* over the declining love of the noble profession of arms on the part of the youth of France, and then gives the screw another turn by raising the price for exoneration to 92*l.**

"Comparisons," as Mrs. Partington says, "are *odorous;*" but, while speaking of foreign armies, and the military systems of different countries, it may be amusing to glance at the opinions of foreign writers on England, few of which are very flattering to our national vanity.

M. Wickede, a German author, in a work published in 1856, called the "Vergleichende Charackteristik" of the Austrian, Prussian, English, and French armies, devotes a long article to criticizing our army. The English officer he describes as nothing but a fine gentleman, who knows but little, and cares less, for his duties, whose only study is his "stud-boock," by which I presume he means the betting-book, and who is hardly ever seen in regimentals, but esteems plain clothes or hunting costume more honourable than Her Majesty's uniform. In fact, he says that the generality of our officers, even those in command of regiments, are so inefficient that they would never be more than corporals in the French or Prussian army. The English soldier he admits to be brave, but says he is utterly helpless in the field.

M. Wickede apparently anticipates criticism, and lest his readers should call to mind the many laurels won by English armies, he very patriotically insists that the Duke of Wellington owed all his successes to the German element in the Peninsular armies; the whole of the outpost duties, he says, fell to their lot—in fact, his countrymen did all the work, and showed the English troops the way to victory!

M. Couturier de Vienne, chef d'escadron d'Etat-Major in the French service, in his work on the military forces of the principal powers of Europe, while noticing M. Wickede's publication, states that he thinks it

* A decree of the 8th April last further raises the sum to be paid for exoneration to 100*l.*, volunteers receiving 88*l.*!

is perhaps going a little too far, to say that English officers are hardly fit to be made corporals of, but gives it as his opinion that they think military duty a sort of degradation, and are much more at home at the "Jockey Club." He further says that our infantry are composed of starving Irishmen and labourers out of work, and our cavalry of thieves and pickpockets collected out of the streets of London or Birmingham. With a spirit of thorough misrepresentation, he adds that we had to send navvies to the Crimea to make the trenches and approaches to Sebastopol, and that in India a native servant must be kept for every trooper to groom his horse and clean his arms and equipments.

Now, it is, perhaps, hardly necessary to observe, that the navvies were sent to the Crimea to construct, not the trenches or batteries, but the railway from Balaklava to the front. As to the grooms to attend on our cavalry soldiers in India, he might have added that the infantry have their packs carried for them on the line of march; not because the men are too lazy and undisciplined to do their duty but because their energies and lives are considered as too valuable to be thrown away, or exhausted in any labour that can reasonably be saved, in that trying climate.

M. Colonjon, writing in the *Spectateur Militaire* for May, 1859, makes the following highly charitable remarks:—

"England has now passed through the first three epochs of her existence, and is rapidly on the wane. True it is that she tries hard to hide her grey hairs under a brown wig, but anyone can see that her feet are gouty, and that decline is strongly marked over her whole system! This quondam queen of the seas seems to forget that, if genius founds empires, selfishness destroys them."

Lieutenant-Colonel Charles Martin, of the Third Lancers, in an article on the French possessions in the Eastern seas, follows up this in another number of the *Spectateur*, by saying that, "as England is evidently failing, the time is coming to make her surrender her ill-gotten possessions," and suggests that the Mauritius should be wrested from us, pointing out that the population, being French, would certainly join an invading force, and France would have her own property again.

The same writer, in an article upon the English military institutions, draws a comparison between the English and French civil forces, and notices the extraordinary respect for authority that exists in England, as shown by the fact of our police being wholly unarmed. "But," he says, "will this continue? No! ere long the people of England will recognise their rights, and will no longer be trampled upon by a cruel, selfish, and tyrannical aristocracy. Then England will know the same commotions that have agitated other nations, and the people, freed from the chains that have bound them, will not be restrained by policemen or constables, but fall into the most frightful excesses. Should such a calamity overtake England, her army, reorganised upon a solid, but at the same time, liberal basis, will be her sole anchor of safety. The *double* mission that it will have to fulfil will not differ in any respect from that of continental armies, instead of playing the 'rôle oisif et incomplet' that it does at present in the United Kingdom."

Colonel Charles Martin's recipe for making the country a perfect

elysium, is evidently to have a conscription, and 500,000 idle soldiers garrisoning our towns, with a guard-house at the corner of every street; possibly a corps of drummers beating the tattoo down Regent-street every evening; our police turned into gendarmerie on the French model, with waxed mustachios, and all the other delightful attributes of a "strong" government. I am afraid, however, that it will be some time before John Bull, notwithstanding the good sense for which Colonel Martin gives him credit, will rise to avenge the injustice and cruelties heaped upon him by the "imperious upper classes," and that he will in the meantime receive the worthy colonel's propositions with the same diffidence that the foxes exhibited when their comrade, who had lost his brush, suggested that they would be much more comfortable if they would part with theirs.

I have selected these extracts quite promiscuously, and could multiply them to any extent, to show the strain of sentiment generally indulged in by continental writers, when treating of England. It would not be easy to say whether ignorance or wilful misrepresentation predominates in them; but it hardly admits of a doubt that an aggressive spirit is thus fostered against England and Englishmen.

But though the columns of the *Moniteur de L'Armée*, and other French journals, teem at intervals with tirades against the selfish policy of Britain, or sneers at our noble Volunteer movement, though foreign writers may be offended because our officers are gentlemen, and French colonels vapour about Chartist insurrections,—in spite of their mutual congratulations on the decadence of our empire, in their hearts they well know that the British lion has not yet lost his teeth or his claws.

France goes to war for an idea, or draws the sword for honour and glory: England shields the weak and the oppressed, exerts her influence, and, if necessary, lavishes her treasure, and pours out her best blood, where the cause is just and righteous. And should the Temple of Janus again be opened, her adversaries will find—if I may venture a parody on the poet's stanzas—that

Britannia *has* her bulwarks
  In spirits bold and free;
Her marshall'd sons the foe will meet
  On *land* as well as sea.

The meteor flag of England
  Can still terrific burn;
And proudly shall her banner float
  Till *with honour* peace return.*

* Original lines:—

Britannia needs no bulwarks,
  No towers along the steep;
Her march is o'er the mountain waves,
  Her home is on the deep.
*   *   *   *   *
The meteor flag of England
  Shall yet terrific burn,
Till danger's troubled night depart,
  And the star of peace return.

CAMPBELL.

Friday, February 22nd, 1861.

Rear-Admiral AUSTIN, C.B. in the Chair.

ON THE SURVEY OF RIVERS.

By Captain RD. COLLINSON, R.N., C.B., Vice-President Royal Geographical Society.

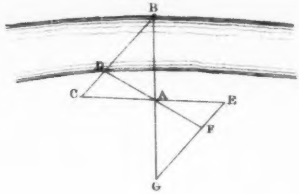
THE subject which I have this day, by the request of the Council of this Institution, undertaken to bring to your notice, is one on which a great deal has been written, and I doubt whether it is in my power to introduce any new matter; but it is one of so great importance to both branches of the service, that I believe a general summary of what ought to be done, and what can be done, by one who has had some practical acquaintance with it, will be received with favour by the members of the Institution.

In dealing with it, it is my intention in the first place to show how much can be effected by small means, and then to endeavour to carry you step by step from the realm of doubt to the region of certainty.

No matter whether it be a cursory survey or a complete work, the first requisite is a method of notation. The books generally in use in the navy for this purpose measure six inches by three and a half inches, this size is not too large to go into the pocket to be protected from wet, and is sufficiently capacious to receive an eye-sketch to assist the memory. The traveller, therefore, will do well to provide himself with a number of these sufficient for the purpose, and on the fly leaf, or in the pocket of the cover, there should be a note of certain constants which he is in the habit of using, while the date and places between which the observations contained therein were made, should be entered, when full, on the back, as a means of ready reference.

The possession of a compass, a watch, and a measure of length, are absolutely necessary, and we will assume in the first instance that these are the only instruments at hand. Having procured a fishing line, mark it off in 25 feet lengths by twine, place a knot at 50 feet, two knots at 100, three at 150, and so on. It will then be in readiness to be used as a measure for bases as well as a log-line. The length of a knot as used on board ship is 48 feet, corresponding to the same portion of a mile that 28 seconds is to an hour; but, as in this instance a watch will be used instead of a sand glass, 30 seconds will prove a simpler division to note than 28 seconds; properly speaking, the length of the knot for this period ought to be 50 feet 11 inches; but the convenience of 50 feet for other measurements, and the comparative small error in the distance thus obtained, warrant its adoption. Instead of a log-ship, a weight sufficient to sink it to the ground is used, and, allowing sufficient stray line for it to reach the bottom, a very fair account of the distance gone over can be obtained, and afterwards entering in a tabular form, the courses and distances traversed, we obtain the means of plotting

Fig. 3.



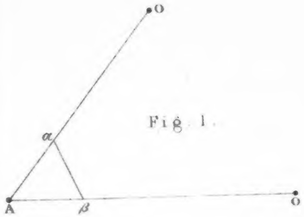


Fig. 1.

Fig. 2.

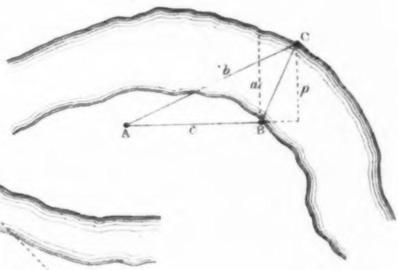


Fig. 4.

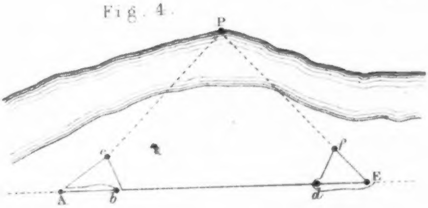
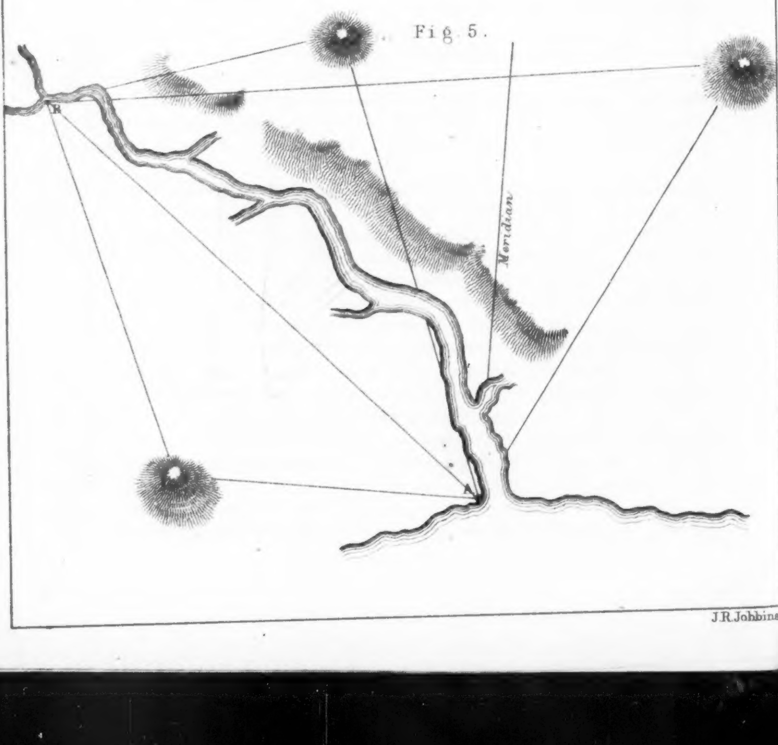


Fig. 5.



J.R.Jobbins

on paper the different traverses, or ascertaining by computation the difference of latitude and difference of longitude.

Proceeding up a river close to one bank, its width may be obtained by taking the bearing of a remarkable object at the water's edge some distance above on the opposite bank, and taking the bearing again when abreast of it; the course and distance traversed in the interval being known, we have two angles and one side given to obtain another side. In the same manner distances of remarkable objects on land may be obtained with an approach to accuracy; but if there is an opportunity of landing, and the bank of the river is comparatively level, the width of the river may be obtained to a much greater degree of precision by several methods. In the last number of the Journal of the Royal Geographical Society there are the following methods of measuring angles and obtaining the perpendicular breadth of the river, by Colonel Everest.

Drive two pegs into the ground (fig. 1), one at a in the direction of O, and the other at β in the direction of O', both at equal distances from A; measure $a\,\beta$. Then $\frac{a\,\beta}{A\,a}$ will be the chord of the angle A to radius unity, which call γ.

Then sin. $A = \gamma\,(1 - \frac{1}{4}\,\gamma^2)^{\frac{1}{2}}$ and cosine $A = 1 - \frac{1}{2}\,\gamma^2$.

In fig. 2, let $A\,B = c$, and the perpendicular breadth of the river $= p$.

$$\text{Then } p = c\,\frac{\text{sine } A \text{ sine } B}{\text{sine } A \text{ cos. } B + \text{cos. } A \text{ sin. } B}$$

Mr. Galton has also published a method with a short table for rough triangulation without the usual instruments, and without the calculation. (See fig. 4 and Appendix A.)

There are several other methods, but I shall content myself by giving you one more from Hutton's "Recreations." (Fig. 3.)

Fix a peg at A, another at C, then another at D, in a straight line between B and C, continue $C\,A$ and $D\,A$, and make $A\,E$ and $A\,F =$ to $A\,C$ and $A\,D$ respectively; lastly, fix a peg at G, in such a manner as to be in line with $A\,B$ and $E\,F$, $A\,G$ will then equal $A\,B$. If it be found impossible to proceed in the direction from A towards E and F, we may take only the half or the third of $A\,C$ and $A\,D$, in which case $A\,G$ will be the half or the third of $A\,B$.

The log-line may be used for these mensurations, or, if a person has been in the habit of counting how many paces he makes in a mile or hundred yards, he will find that he is capable of measuring a very fair base. Sometimes one is apt to forget the number of hundred paces he has taken: transferring an article from one hand or pocket to another, or using a string of beads, will prevent confusion.

In addition to the width of a river, the height of the bank, or what a flood has risen to on a previous occasion, is an object of great importance.

Where floods of considerable height occur, reaches long enough to obtain a level will usually be found.

Thus, if the eye is 8 ft. above the level, an expanse of 3 miles is required

"	14 ft.	"	4	"
"	22 ft.	"	5	"
"	32 ft.	"	6	"
"	43 ft.	"	7	"

Should the expanse be sufficient, procure two straight poles, mark them to feet, place one of them upright by means of a plummet, at the water's edge, retire from it in a direction opposite to the greatest extent of water, and placing your eye at the water-mark left on the trees or bushes, direct your assistant to slide the second pole up the one already placed until its top comes in line with the level of the water ; you will find that the height of the pole above the water nearly corresponds with the height of your eye above the present level.

In the event of the reach not being long enough, cross over to the opposite shore of the river, leaving behind your assistant with the pole placed vertically at the water's edge, having taken care to instruct him to obey your signals ; place your eye, say three feet above the water's edge, and direct your assistant to raise the pole until its top comes in line with the flood mark, then having obtained the distance across the river, you have that as a base with the height of the pole, less the height of your eye above the water as a perpendicular. To compute the angle of elevation, measure the distance from the pole back to the flood-mark, and adding it to the width of the river, a base is obtained, while the angle of elevation thus got will give the height.

This method may be used for trees or buildings, and their height above the ground obtained, provided the bole or foundation can be seen from the opposite shore.

Elevations of these objects may also be obtained by means of their shadows, for as the length of the shadow of a pole is to its height, so is the length of the shadow of a building or tree to its elevation.

The variation of the compass should be obtained by bearing of the sun either at rising or setting, or by the pole star in the northern hemisphere. The mensuration of base by sound, requiring the aid of no other instrument than a watch, may be properly introduced here.

Sound, travelling as it does at the rate of 1140 feet per second, or a geographical mile in $5\frac{3}{4}$ seconds, affords in the absence of other means a ready means of obtaining a base. Common watches do not, but pocket chronometers invariably beat 10 times to 4 seconds. Box chronometers usually beat half-seconds. The beats of a common watch should be tested by holding it to the ear and counting the beats in a minute by the chronometer, this will be found to be good practice for actual observation, and by looking in the direction of the gun, you are enabled to commence the instant of the flash, and obtain a more minute division of time than is to be got by watching the hands of a watch. With practised observers, and firing to and fro, results quite sufficient to enable you to plot upon an inch scale will be obtained. Where there is no auxiliary watch, recourse may be had to the pulse, and if there is no wind, to a pendulum improvised for the occasion. The state of the pulse, and the number of oscillations may be determined, both previous and subsequent to the observation. Having so far shown what can be done with what may be called primitive assistance, I have now to call your attention to reflecting instruments, by means of which you are not only enabled to obtain greater accuracy in plotting your work, but fix your geographical position by astronomical observations.

On the present occasion my business is not to enter into detail respecting the adjustment, or to give in full the different methods of calulation, but

to lay down some general rules for the guidance of those who are about to undertake the exploration of a river.

In the first place geographical positions determined astronomically should not be considered as firmly fixed, unless the latitude is obtained by celestial objects N. and S. of the meridian, and the time by A.M and P.M. sights of the sun or stars E. and W. of the meridian.

With but one boat or one observer, recourse must still be had to the ground-log and compass, but, as in all probability landmarks and mountains at a distance from the river will be seen, we will now proceed to show how they can be turned to account.

The latitude and the longitude of the starting point having been ascertained, and a true bearing of any one remarkable object obtained, from which angles to others may be taken, the traveller, on arriving at his next astronomical position, and obtaining bearings and angles to the same objects, can obtain the distance between his two places of observation, either by laying them down on a chart graduated for the purpose, or by computation, by spherical or plane trigonometry. In Mr. Simms' useful little Manual on Instruments, the length of feet in a second of latitude and longitude is given for each degree of latitude; though this will not give the distance with the same accuracy as when the figure of the earth is taken into consideration, yet it may be assumed as sufficient for geographical, if not geodetical objects.

In the diagram (fig. 5) the distance between the two astronomical stations is assumed as sixteen miles, and the bearing N. 50° W.; at *A*, the first station, High Peak, bore N. 27° E.; Saddle, N. 20° W.; Dome, S. 35° E. At *B*, High Peak bore N. 85° E.; Saddle, N. 75° E.; Dome, S. 35° E. These objects being fixed, any position on the river can be obtained by a bearing of any two of them, and the dead reckoning corrected. They can also be used in filling in the topography of the country, by obtaining what are termed transit bearings—that is to say, the bearing when a lower hill, a remarkable object, or the foot of a range comes in line with the one behind it.

With two boats and an assistant, recourse should be had to micrometical measurement, one of the boats furnished with a board twenty feet long, weighted at one end, so as to ensure its being suspended vertically.

In a little pamphlet published to accompany Rochon's micrometer, the distance is given for each angle from 1″ to 38′.

At 1 mile	20 feet subtends an angle of	13′ 1″		
2 „	40	„	„	„
3 „	60	„	„	„

The value of the scale may be obtained by computation from a measured base, or, more directly, by seeing how many divisions are occupied by the sun's diameter, and dividing the semi-diameter in the "Nautical Almanac" by half their number. This instrument was used with great advantage by Admiral Fitzroy in the Straits of Magelhaen and the survey of Terra del Fuego. With three or more boats the triangulation of a river can be accurately and rapidly performed; and it was in this manner that the Yangtsekeang was surveyed by Captain Kellett in 1841 from Nankin to the sea. The last stations, on the close of a day's work, were taken up on shore, or a pole was left in shallow water, where the current was not

likely to take it away, so that the same positions were resorted to in the morning; the base was repeatedly verified by sound, and recourse had to true bearings. When the river became wider, the triangulation was continued by vessels, which, when the effect of the flood-tide was reached, were moored. In the recent exploration of the upper course of the Yangtsekeang to Hankow, under Captains Barker and Sherard Osborn, the steam-vessels measured their distance by patent log, and obtained the rate of the current when anchored for the night, at which time astronomical observations were taken, and the dead reckoning satisfactorily worked in between them.*

The artificial horizon was used with good result on board ship by Captain Bethune at slack water, when he surveyed the entrance to this river in 1840, and in proceeding along the north coast of America, between the ice and the shore, when the distance of the land was too near for the natural horizon we constantly used it, and such was the smoothness of the water, that I have obtained good observations with the vessel going three knots.

In sounding operations, recourse is had to the station pointer, an instrument with which the position is obtained with great accuracy, by means of two angles between three objects. The centre object ought to be the nearest, and if both angles are about 60°, the position will be more difficult to fix, than if a large and a small angle are employed. This useful instrument is not sufficiently appreciated, with it a ship's position can always be obtained with much greater accuracy than by compass bearings, and without the instrument an excellent substitute may be used by protracting the angles upon tracing paper.

For surveys of more elaborate character, the theodolite must be used and stations erected along the banks of the river, and a comparatively level spot selected for the measurement of a base. The latter may be accomplished with great nicety, by placing poles from twenty to thirty feet apart along the line to be measured. Level the theodolite, and looking along the poles. place a mark on each, where the horizontal wire of the telescope intersects the pole, then stretch a light line along the base, and stopping it up to the marks, measure it with tapes or wooden battens; extend your base by well constructed triangles, and find the sides by computation, until you have attained a sufficient distance to plot from.

Though the theodolite is of great importance in trigonometrical operations, we find from experience, no matter how large it may be, that it cannot be depended upon for astronomical observations, unless great pains are taken in securing a proper foundation and protection from the wind. Its great value to the surveyor is the measurement of horizontal angles, and low angles of elevation. Unless a solid foundation is obtained, and a covering from the atmosphere, the sextant will give a more trustworthy result than the direct instrument. Reflecting instruments however as at present constituted have two great defects, viz. the mensuration of angles under 20° and above 72° in the artificial horizon, consequently to the theodolite we must be indebted for the correct elevation of those heights which cannot be reached. In taking these observations, the instrument should invariably be reversed, and when the distance is greater than ten miles, a correction for the ellipticity of the earth is necessary. A large

* See Appendix B for an account of a Running Survey of the Irrawadi.

theodolite capable of taking altitudes near the zenith is of great value to the traveller within the tropics, as there, from the rapid motion of the sun in altitude near noon-time, azimuth and latitude may be obtained in the course of half an hour.

Elevation above the level of the sea is a most important item in the survey of rivers. Barometrical measurement and strict trigonometrical surveys were for many years our only means of ascertaining the fall of water throughout a great extent of country. Barometers, though difficult to transport, have been taken to the sources of most of the European rivers, and have been carried to the upper waters of the Ganges, the Brahmaputra and the Indus. They are however too cumbersome and too fragile for the general traveller, while an extensive series of triangulation is utterly beyond his means. We have however a simple portable instrument, which owes its introduction to the scientific world in a great measure to Colonel Sykes and its present improved condition in as great a measure to Mr. Galton. I allude to the apparatus for boiling water. In its present form, the bull's-eye lamp, commonly used for astronomical observations or other purposes is so fitted that by the introduction of a lamp holding a wick supplied with spirits of wine, the water in the little boiler, which holds scarcely more than half a gill, is speedily brought to a state of ebullition. Formerly the thermometers were placed perpendicularly over the boiler, but it was found that the escape of steam prevented the eye making that close observation which is necessary. The thermometer now by Mr. Galton's arrangement is placed at right angles to the boiler, and the effect of parallax in the scale is done away with by your being enabled to see it reflected in the mercury.

Thus the means of ascertaining the height above the sea, instead of being one of the most difficult of our geodetical observations, has become as simple as it is portable.

This most desirable object brings me to another important question in our river surveys, viz. the mensuration of the quantity of water carried daily by the river to the sea. I say important, for rivers are our natural rain gauges, and through them we can obtain an accurate insight into the humidity of the atmosphere surrounding those basins which they drain. Though it may not be in the power of most travellers to obtain the measurement and observations which are requisite for great accuracy, yet it is a matter of so great importance that I cannot argue too strongly upon all who have the opportunity of making observations upon the descent of floods to do all in their power to ascertain the volume of water, and the rate at which it moves.

The value of this knowledge in a strategetical point of view need not be expatiated upon, and the necessity of fording a river, prior to an almost certain period, or the propriety of delaying an advance until by previous knowledge it is known the navigation of a river will be opened, have contributed to the success of many a campaign.

Opportunity, therefore, should be taken in a portion of the stream where it is confined by banks at the highest flood, to obtain a correct section of the bed of the river during the dry season, and to extend the measurement to the highest flood-mark, so that as the river rises the number of square feet contained in the section may be known.

The velocity of the current at the surface can be obtained by the log-

ship; but a more accurate method is that simple one called the Dutchman's log. Having measured a distance on the bank, or by veering one boat a certain distance astern of the other, and noting the time a chip floats from one to the other, the mean velocity may be obtained tolerably near the truth by a rod of wood loaded at one end sufficient to float upright in still water, the greater velocity at the upper surface will make the rod incline towards the stream. Consequently it will float in a oblique position, the top of the rod will move slower than the water at the upper surface of the river, and the bottom move faster than that in the lower. In addition to which a correction is required for the friction at the sides and bottom, for which the following formula has been found by experiment.

$A=$ the area in square feet.
$L=$ the length of the sides and bottom.
$I=$ the fall in two miles in inches.

Then V, the velocity in inches per second, $=\frac{10}{11}\sqrt{I\times\frac{A}{L}}$

It has also been found that water moving with the velocity

3	inches per second	will move	fine clay.
6	"	"	fine sand.
8	"	"	coarse.
4	"	"	gravel, small.
7	"	"	size of pea.
12	"	"	size of bean.
24	"	"	inch size.
36	"	"	egg size.

Soundings for this purpose, or if required for engineering purposes, should be taken in straight lines across the river, which can be done by keeping two objects in one, and taking an angle to a third whenever a change in the depth occurs. The progress of the tidal wave up rivers, and its gradual absorption, are of so great importance that the opportunity of making simultaneous observations throughout its course should not be lost, and the rise and fall at different periods of the lunation should be carefully noted, as they afford the truest indication of the dynamic force.

Contour lines from low-water mark on shoals that dry, as well as on the banks of rivers, may be obtained by fixing poles and determining their position, either by the theodolite or sextant angles, and comparing the instant they are left dry, or the moment the flood reaches them, with a tide gauge. Whenever the latter is raised, care should be taken to compare it with some fixed object, so that the observations then made may be referred with accuracy to others at a future period.

APPENDIX A.

TABLE FOR ROUGH TRIANGULATION WITHOUT THE USUAL INSTRUMENTS AND WITHOUT CALCULATION.

(See Fig. 4.)

A TRAVELLER may ascertain the breadth of a river, or that of a valley, or the distance of any object on either side of his line of march, by taking about 60 additional paces, and by making a single reference to the annexed table.

Suppose that he is travelling in the direction A E, and desires to know the distance of some object, P, from A. Let him proceed as follows:—

Walk ten paces from A towards E (to *b*). Back to A. Ten paces towards P (to *c*). From *c* to *b*, *counting the paces to the nearest quarter-pace* (*c b* is the chord of the angle at A to radius 10).

Walk on towards E. The distance A E must be taken as 100. It need not be 100 *paces*, but may be 100 of any convenient unit of length, as feet, fathoms, minutes' walk, furlongs, &c.; or it may be some simple multiple of 100, as 200, 300, 500, 1000.

When 10 paces short of E (at *d*), mark the spot and walk on to E. Thence towards P (to *f*). From *f* to *d*, *counting the paces to the nearest quarter-pace* (*f d* is the chord of B to radius 10).

This completes the operation. Nothing has to be recollected but the values of *c b*, of A E, and of *f d*.

To find A P, enter the table with *c b* at the side, and *f d* at the top.
" E P, " *f d* " *c b* "

The tabular number is the value of these quantities, *supposing* A E *to have been* 100. If it be 200, 300, 500, &c., the tabular number must be multiplied by 2, 3, 5, &c., as the case may be. Beyond this, there is no calculation. If A E has been taken in paces, the tabular number will be in paces also; if in minutes' walk, in minutes' walk, and so on.

The angles corresponding to the chords, viz. *c* A *b* (or P A E), for *c b* and *f* E *d* (or P E D), for *f d*, are also given. Examples:—

c b is 5 paces; A E 100 paces; *f d* $6\frac{1}{2}$ paces; then A P=67; E P=53: *c* A *b*=28° 58′; *f* E *d*=37° 56′

c b is 5 paces; A E 300 paces; *f d* $6\frac{1}{2}$ paces; then A P=201; E P=159: *c* A *b*=28° 58′; *f* E *d*=37° 56′

c b is $5\frac{1}{2}$ paces; A E 100 paces; *f d* $6\frac{1}{2}$ paces; then A P=65; E P=56; *c* A *b*=31° 56′; *f* E *d*=37° 56′

c b is $10\frac{3}{4}$ paces; A E 100 paces; *f d* 8 paces; then A P=79; E P=98; *c* A *b*=65° 2′; *f* E *d*=47° 10′

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The tabular number is the value of these quantities, *supposing* A E *to have been* 100. If it be 200, 300, 500, &c., the tabular number must be multiplied by 2, 3, 5, &c., as the case may be. Beyond this, there is no calculation. If A E has been taken in paces, the tabular number will be in paces also; if in minutes' walk, in minutes' walk, and so on.

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c b is $10\frac{3}{4}$ paces; A E 100 paces; *f d* 8 paces; then A P=79; E P=98; *c* A *b*=65° 2′; *f* E *d*=47° 10′

If A E be a north and south line, the *bearing* of P from A, as represented by the angle *c* A *b*, is to be found by simply ascertaining the value of *c b*.

The most methodical way of making these measurements is to select some tuft of grass, or stone, or stick, that may happen to be lying on the ground, as the starting-point, A. Then to mark *b* by placing any object there, or by planting a stick, which can be recovered on returning to *b* from *c*. D is to be marked in the same way. E requires no mark at all; neither does *c* nor *f*.

Particular care must be taken to walk in a straight line from A to E. It will surprise most people, on looking back at their track, to see how curved it has been, and how far E *d* is from pointing truly towards A. It is always well to sight some distant object in a line with E, when walking towards it.

The triangle P A E must be contrived so that none of its angles are less than 30°, or the chords of the angles at A and E will not be found in the Table. These cases do not give reliable results, and have therefore been omitted.

Should a traveller have no tables by him, he can always *protract* his measurements to a scale on a sheet of paper, or even on the ground, and so solve his problem. If real accuracy be aimed at, it is clear that careful measurements of the base and chords, combined with a sufficiently rigorous calculation, will give it.

FRANCIS GALTON.

TABLE for MEASUREMENT of the BREADTHS of RIVERS, and other kinds of ROUGH T
CALCULATION. For the purposes of Travellers. By

(For explanation of its use, see Appendix

NUMBER OF PACES IN CHORD OPPOSITE TO THE REQUIRED SIDE

NUMBER OF PACES IN CHORD ADJACENT TO THE REQUIRED SIDE, (TO A RADIUS OF 10 PACES).

		5				6				7				8				9				1	
		0	1/4	1/2	3/4	0	1/4	1/2	3/4	0	1/4	1/2	3/4	0	1/4	1/2	3/4	0	1/4	1/2	3/4	0	1/4
5 0	28° 58′	57	59	60	62	64	65	67	68	70	71	73	74	75	77	78	80	81	82	84	85	87	88
1/4	30 26	56	58	60	61	63	64	66	68	69	71	72	74	75	77	78	80	81	82	84	85	87	88
1/2	31 56	55	57	59	61	62	64	65	67	69	70	72	73	74	76	78	79	81	82	84	85	87	88
3/4	33 30	54	56	58	60	62	63	65	67	69	70	71	72	74	76	77	79	80	82	84	85	87	88
6 0	34 56	54	56	57	59	61	63	64	66	68	69	71	72	74	76	77	79	80	82	84	85	87	88
1/4	36 26	53	55	57	59	60	62	64	66	67	69	71	72	74	75	77	79	80	82	84	86	87	89
1/2	37 56	53	54	56	58	60	62	63	65	67	69	70	72	74	75	77	79	80	82	84	86	87	90
3/4	39 28	52	54	56	57	59	61	63	65	66	68	70	72	73	75	77	78	80	82	84	86	88	90
7 0	41 0	52	53	55	57	59	61	63	65	66	68	70	71	73	75	77	79	81	82	85	86	88	90
1/4	42 30	51	53	55	57	58	60	62	64	66	68	70	71	73	75	77	79	81	83	85	87	88	91
1/2	44 4	51	53	55	57	58	60	62	64	66	68	70	71	73	75	77	79	81	83	85	87	89	91
3/4	45 36	50	52	54	56	58	60	62	64	66	68	70	72	74	75	77	79	81	84	86	88	90	92
8 0	47 10	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	79	82	84	86	88	91	93
1/4	48 44	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	85	87	89	91	94
1/2	50 20	49	51	53	55	57	59	61	63	65	68	70	72	74	76	78	80	83	85	88	90	92	95
3/4	51 54	49	51	53	55	57	59	61	63	65	68	70	72	74	76	79	81	83	86	88	91	93	96
9 0	53 30	49	51	53	55	57	59	61	64	66	68	70	72	75	77	79	82	84	87	89	92	94	97
1/4	55 6	49	51	53	55	57	59	61	64	66	68	70	73	75	77	79	82	85	88	90	93	96	98
1/2	56 4	49	51	53	55	57	59	62	64	66	68	71	73	76	77	81	83	86	89	91	94	97	100
3/4	58 22	48	51	53	56	57	59	62	64	66	69	71	74	76	79	81	84	87	90	92	95	98	102
10 0	60 0	48	51	53	55	57	60	62	65	67	69	72	74	77	79	82	85	88	91	94	96	100	103
1/4	61 40	48	51	53	55	57	60	62	65	67	70	72	75	77	80	82	86	89	92	95	98	102	105
1/2	63 22	48	51	53	56	58	60	63	65	68	70	73	76	78	81	84	87	90	93	97	100	104	107
3/4	65 2	49	51	53	56	58	61	63	66	68	71	74	76	79	82	85	88	91	95	98	102	106	109
11 0	66 44	49	51	53	56	58	61	64	66	69	72	74	77	80	83	86	89	93	97	100	104	108	112
1/4	68 24	49	51	54	57	59	61	64	67	70	72	75	78	81	84	88	91	95	98	102	106	110	115
1/2	70 12	49	52	54	57	59	62	65	67	70	73	76	79	83	86	89	92	97	100	105	109	113	118
3/4	71 58	49	52	55	57	60	63	66	69	71	74	77	81	84	87	91	95	99	102	107	112	116	121
12 0	73 46	50	52	55	58	60	63	66	69	72	75	79	82	85	89	93	97	101	105	110	115	120	126
1/4	75 34	50	53	55	58	61	64	67	70	73	76	80	83	87	91	95	99	103	108	113	118	123	130
1/2	77 22	50	53	56	59	62	65	68	71	75	78	81	85	89	93	98	102	106	111	117	122	128	135
3/4	79 10	51	54	57	60	63	66	69	72	76	79	83	87	91	96	100	105	110	115	120	127	133	140
13 0	81 6	52	55	57	61	64	67	70	73	77	81	85	89	93	99	103	108	113	119	125	131	138	146
1/4	82 58	52	55	58	62	65	68	72	75	79	83	87	92	96	101	106	111	117	123	130	136	144	152
1/2	84 56	53	56	59	62	66	70	73	77	81	85	90	95	99	104	109	115	121	128	135	143	150	
3/4	86 52	54	57	60	64	67	71	74	79	83	88	92	97	102	107	114	120	126	133	141	150	158	
14 0	88 52	55	58	62	65	69	73	77	81	85	90	95	100	106	112	118	125	132	140	148	158		
1/4	90 54	56	60	63	67	71	75	79	84	88	93	98	104	110	116	123	130	137	147	158			
1/2	92 56	57	61	65	69	73	77	81	86	91	97	102	108	114	122	129	137	145	156				
3/4	95 2	58	62	66	70	75	80	84	89	95	100	106	112	120	127	136	145	156					
15 0	97 10	60	64	68	72	77	82	87	93	99	105	110	118	126	135	143	155						
1/4	99 4	62	66	70	75	80	85	91	97	103	109	117	125	134	143	154							
1/2	101 36	64	67	73	78	83	89	95	102	108	116	123	138	141	154								
3/4	103 54	66	71	75	81	87	93	100	107	115	123	132	141										
16 0	106 16	69	74	79	85	90	98	105	113	121	131	140	151										
1/4	108 42	72	77	84	90	96	104	112	121	131	140	151											
1/2	111 12	76	82	88	95	103	110	120	130	141													

[To follow page 76.

' ROUGH TRIANGULATION, without " INSTRUMENTS," and without
vellers. By FRANCIS GALTON.

see Appendix A.)

EQUIRED SIDE, (TO A RADIUS OF 10 PACES).

	10				11				12				13				14			
$\frac{3}{4}$	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	0	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$
85	87	88	89	91	92	94	95	97	98	100	101	103	105	107	109	110	113	115	118	120
85	87	88	90	91	93	94	96	97	99	101	102	104	106	108	110	112	114	117	120	122
85	87	88	90	91	93	95	96	98	100	102	103	105	107	109	112	114	116	119	122	124
85	87	88	90	92	93	95	97	98	100	102	104	106	108	111	113	116	118	121	124	127
85	87	88	90	92	94	96	97	99	101	103	105	108	110	113	115	118	120	124	126	130
86	87	89	91	92	94	96	98	100	102	105	107	109	111	114	117	120	122	126	129	133
86	87	90	91	93	95	97	99	101	103	106	108	111	113	116	119	122	125	128	132	136
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87	89	91	94	96	98	101	103	106	109	112	114	118	121	125	128	132	136	141	146	152
88	90	92	94	97	99	102	104	107	110	114	116	120	123	127	131	135	140	145	150	
88	91	93	95	98	101	103	106	109	112	115	118	122	126	130	134	139	144	149	156	
89	91	94	96	99	102	105	108	111	114	117	121	125	129	133	137	142	148	153		
90	92	95	98	100	103	106	109	112	116	119	123	127	132	136	141	147	153			
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92	94	97	100	103	106	109	113	117	121	125	129	134	139	144	150					
93	96	98	102	105	108	112	115	119	123	128	132	138	143	149	155					
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APPENDIX B.

AN ACCOUNT OF A RUNNING SURVEY OF THE RIVER IRRAWADI,

By Lieutenant HEATHCOTE, H.M. Indian Navy.

A running survey of the Irrawadi river above the frontier of the British possessions in Pegu was executed on the occasion of the ascent of that river by the diplomatic mission despatched by Lord Dalhousie in 1855, to make return presents to the King of Ava, and to negociate a treaty of commerce. The mission started in two flat-bottomed river steamers, drawing between three and four feet water, each towing a flat or large barge of about equal size and draught with the steamer. On the British frontier where it abuts on the Irrawadi, two boundary pillars are erected; their relative position and distance from each other has been well ascertained, and the river within this boundary has been well surveyed. It was the duty of the surveyors of the mission to produce as accurate a survey of the river to the north of this boundary within the territories of the King of Burmah as the time occupied in the passage of the mission allowed them. The principle laid down for the execution of this duty was a combination of the three elements of time, speed, and transit bearings; the result being checked and confirmed by astronomical observations. The surveyors were well provided with instruments, and five chronomers were placed in a cabin of the largest flat, upon a stand purposely erected, to avoid vibration, or the effects of concussions, and to give every facility for winding and comparison. At each end of the roof of the flat, which was about 15 feet above the water, and 120 feet long, standards were set up to give a line of sight at right angles to the keel of the vessel. These were used to ascertain the rate of progress, by noting the inverval between the passing by the two sets of standards of any fixed object on the bank, when the vessel's course was perfectly straight. A good prismatic compass was set up on the roof of the flat; and, starting from a given point, and noting time and speed, the transit bearing of every point or object (especially those on the bank) with every other that was worth remark was accurately noted. Objects in the interior were observed in the same way, and these observations, both backwards and forwards, were made as numerous as possible, so as to act as a check one against another. Time of arrival, and speed, at every point or object before observed, was again noted, the course being principally along either one bank or the other, to avoid the extreme strength of the mid-current. The eventual plotting of the chart was throughout kept constantly in view, and the connection between all the various objects carefully preserved. To avoid the errors, to which observations of the speed as tested by the standards were liable from any accidental deviation from the vessel's straight course, these observations were taken very frequently, and

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their results where very satisfactory, as the vessels steered as steadily as could be desired, the flat being towed alongside the steamer. The speed of the vessels over the ground, the progress being against the stream, averaged 80 to 90 yards per minute, in exceptional cases ranging so low as 35 to 40, and so high as 160. The rate through the water was found in the ordinary way. A Burmese was at hand to give information as to the names of the villages, &c., and, as every point could not be named (nor, if so, would it have been convenient to use their names), each point or other object was denoted by the degree of the prismatic compass by which it first came under observation.

The vessels were always moored to the bank shortly after sunset. Then came observations of stars with the artificial horizon for latitude and longitude, and, as our stay at the principal places *en route* generally extended to a day, very frequent opportunities were found for ascertaining the rates of the chronometers. Chronometer measurements were thus obtained under circumstances peculiarly favourable, and they were again checked on the return passage of the vessels.

This survey does not pretend to mathematical precision: it is merely a sketch survey, rapidly taken under peculiar circumstances. Perhaps the astronomical observations are its most valuable results; nevertheless, the sketch itself will be found to possess such a degree of accuracy as can ordinarily be obtained when the opportunities for surveying are no greater than those afforded by the passage up an almost unknown river for the first time in a steam vessel.

At Amerapoora a trigonometrical survey of the water approaches to the capital was obtained, as also a section of the river at a favourable point, and the discharge of water at the prevailing season.

Friday, March 1, 1861.

CAPTAIN E. G. FISHBOURNE, R.N. C.B. in the Chair.

MILITARY SURVEYING.

By CAPTAIN S. B. FARRELL, R.E. Professor of Military Topography, Royal Staff College, Sandhurst.

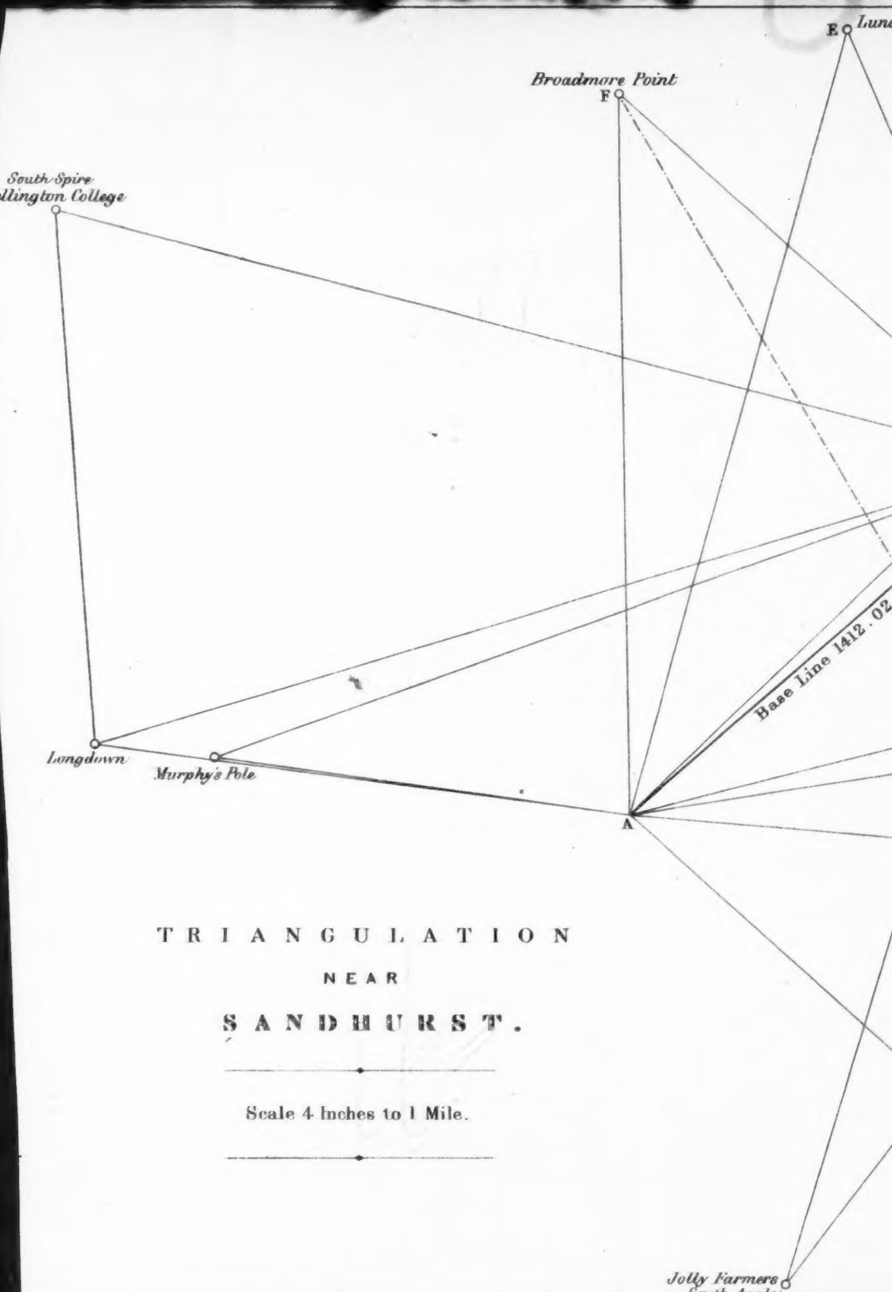
THE subject which the Council of this Institution has done me the honour to request I would bring before you in the form of a lecture, is one of a purely technical character, having, in the general acceptation of the term "Military Surveying," no very wide limits, and involving simply a brief exposition of the principles of an art which may be easily acquired and practised. It is scarcely possible, therefore, to make its dry details interesting, and I am just as much puzzled as to how any remarks that may be made here can be made profitable to any one reading them without his having before him such instruments as are used in the course of our work of surveying. For explanation concerning them let me therefore refer to such books as Major Jackson's "Military Surveying," or Captain Drayson's practical work on the same subject; while I will at once state that the principal objects I shall keep in view in this Lecture are, 1st. To attempt to show that our Surveying is simple, easily to be acquired, and useful (any officer, whether talented as an artist or not, may learn to make a good serviceable plan or map). 2nd. Strongly to urge the propropriety of all students keeping to one style of military drawing. Under existing regulations, proficiency in this art is a *sine qua non* with reference to Staff appointments; and great care has been taken by the Council of Military Education, and the Officers and Professors working under them, to make its practice uniform in all respects. We have thus had the advantage of collecting by authority, comparing together, and studying the plans, principles, and practice of foreign nations as well as of our own, and the advantage derived from these sources shall be set before you at this time.

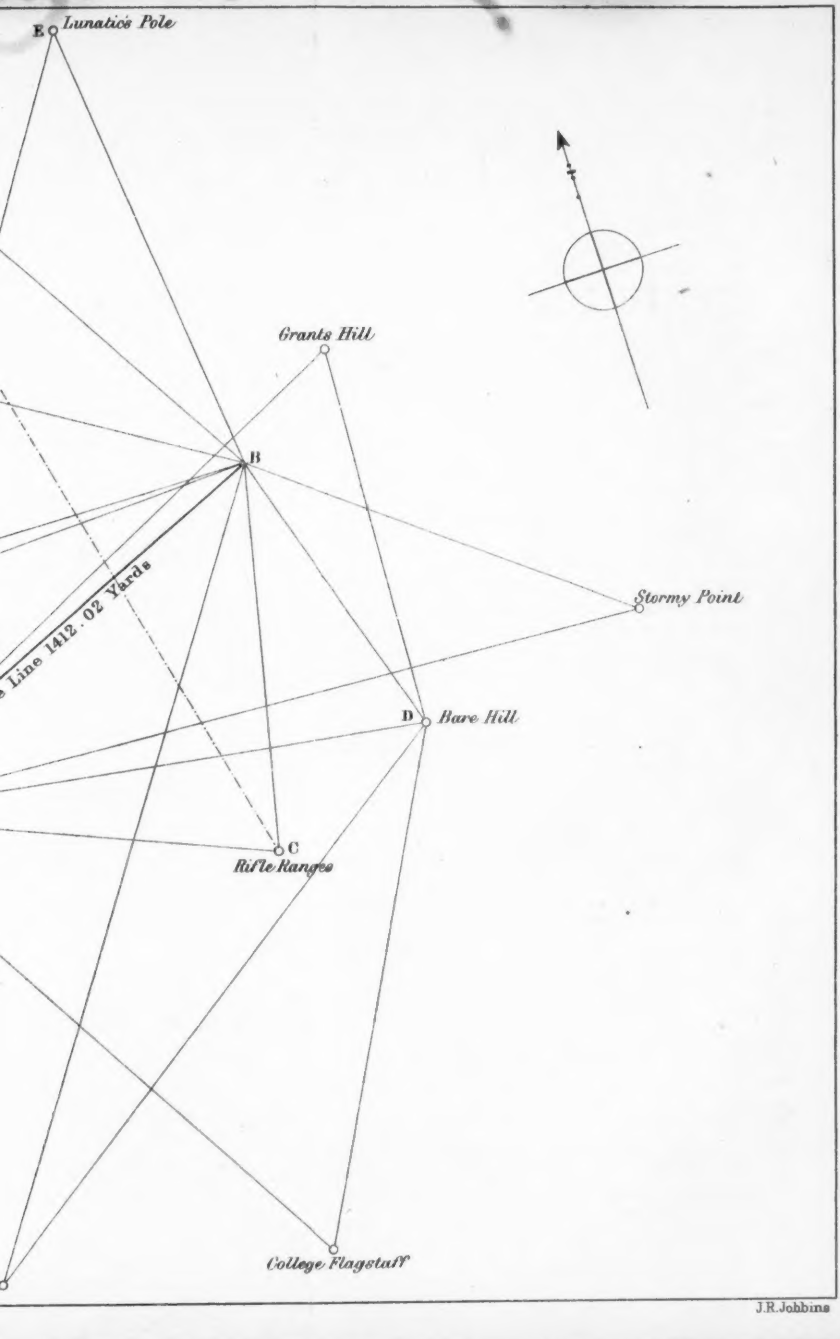
Military Surveying is not only recognised as an important duty, but it often-times affords great interest to military men, and, as compared with other matters of instruction, has generally been found highly popular: encouraged and promoted as it now is by Generals commanding in camps and large garrisons, it may well be recommended to the attention of officers generally. 1st. "*It pays;*"—brings in some return for labour expended. It is both satisfactory and pleasant to execute any work of value. It has been proved to be easy of acquisition, and I often hear it remarked by officers with whom I have been associated, on looking over their original plans and sketches, "Why, six months ago I could not have believed that I could have turned out a plan like this." Again, it

may induce and facilitate the prosecution of much higher studies, such as Geology, Military History, Landscape Drawing, Geographical and other reading; while, if prosecuted with zeal and ability, it often enables officers to amass information of the most valuable character in foreign countries. Favoured with such opportunities, they may employ their leisure time most profitably; and, lastly, they may be induced to take a special interest in our national works of survey and topography, which are second to none. I point to these our Ordnance Surveys, our military reports respecting foreign possessions, and the present labours of the Topographical Department of the War Office, because, as in all matters requiring active exertion, industry, and excellence, in Art generally, it is both necessary and encouraging to the beginner to have some standard of excellence—works in which he may at once feel a legitimate pride, and whose recognised value stimulates to continuous exertion. To become in a measure identified with these national works is an honour of itself, and at the present day the original sketches sent home by officers serving abroad are received at the Topographical Office by Sir Henry James, and published in the highest style of art.

The instruments in use in Military Sketching and Surveying are very well described in the books referred to (Jackson and Drayson); you cannot become familiar with them at a glance, nor by any cursory description which I could now give. Practice alone will render their use easy and satisfactory, but with *that*, you may in a short time acquire great confidence in handling them. The theodolite will best impress upon your mind and memory the system of angular measurements, and, being fixed on a tripod, it can be worked in a convenient manner. The smaller instruments for measuring horizontal angles, viz. sextant, prismatic compass, &c. &c., in more general use among military sketchers, are on rather a small scale for beginners. I find great value in teaching first principles with a theodolite.

Supposing now that we have learnt the uses and manipulation of the instruments already referred to; let us imagine we are about to make a survey of a small tract of ground, say about 6 square miles. We are about to take such measurements on the ground as shall enable us to mark down on paper the relative position, dimensions, and character of objects on the surface of that ground. We consider first what sized plan we are in want of. Shall it be a large plan or a small one? shall it embrace minute details or not? The more you wish to have recorded the bigger your plan must be. Your work will be on a large scale or a small, according to ultimate ends in view. This determines the *Scale* of the plan. Let us take a good medium scale, say six inches to a mile; that point settled, every line on paper six inches long will be held to represent one mile on the ground, and our design will now be to *plot*, or mark on paper all the objects found on the ground, so that their relative positions shall be preserved, To do this, we are not obliged to measure the exact distances between *every* two or three objects; we measure one good line somewhere on our ground (about the middle, if possible). We do this with a rope, tape, or chain, or with still better contrivances (Compensation bars, &c.), according to the nature of the work on hand. From the two ends of the line A B, Plate I., we could determine


E
Broadmore Point
F
South Spire
Wellington College
Longdown
Murphy's Pole
A
Base Line 1412.02
Jolly Farmers
South Angle
TRIANGULATION
NEAR
SANDHURST.
Scale 4 Inches to 1 Mile.


E Lunatic's Pole
Grants Hill
B
e Line 1412 . 02 Yards
Stormy Point
D Bare Hill
C
Rifle Ranges
College Flagstaff
J.R.Jobbins

the exact position of the point C if we actually measured up to it by chain; but can we not adopt a simpler method? C is the apex of a triangle of which A B is the base (already ascertained); now find the angles made with A B by lines directed on C from A and B; you then have one side of a triangle (measured), and two (or all) of its angles; Trigonometry will do the rest. You can get the exact position of C without ever going near it, by the properties of triangles. Extend this plan of operations so as to arrive at the position of D, E, F, &c., and any number of points or places on the ground, and you have what we call a *triangulation*.

There are instruments called *protractors*, which enable you to protract or lay down angles on paper so accurately, that for Military Surveys (works of limited extent on small scales) it is not always necessary to *calculate* positions of C, D, &c., for they can be accurately determined by the intersection of the protracted bearings. Observe now the uses and value of your triangulation. It simplifies your work of linear measurement; it establishes from a central well-chosen line, which can be very accurately measured, the exact position of many points or places on the confines of your ground, or on its more remarkable features. It not only saves time and trouble, but it ensures accuracy, makes a skeleton network to brace together your survey, saves a multiplication of errors sure to result in measuring long lines, and furnishes also lines of direction across your work which greatly facilitate its execution.

In applying these principles practically, we first carefully walk over and examine well the ground, and choose some fitting locality for the measurement of a base—say, about 1,000 yards in length for a six-mile survey. It is usual to look for a very level place, because a line along it can be measured to a nicety. The extremities of this line must be clearly visible, each from the other, and they must afford extensive views of the surrounding country, in order that observations may be made of distant stations. Then, by the use of instruments, we ascertain the relative positions of these points by triangulation.

It is a point not enough dwelt upon by authors of works on Military Surveying, that from each end of the base there should be a very clear view—the ends, in fact, should be well exposed, not hemmed in by heights, woods, or other large masses circumscribing the horizon. By simple *intersections*, work can be plotted much more accurately than is commonly supposed. It can be plotted on the scale or scales commonly used in military surveys quite accurately to the extent of the observations themselves, provided a certain number of checks are used; and as this method saves much time, it is very desirable to commend it to a certain degree, as much of the value and usefulness of a military sketch may depend upon the promptness with which it is handed in to a commanding officer. The extreme nicety of measurement of survey "bases" may well be studied by all interested in the subject, and some one well-approved system must be practically carried out, whenever it is proposed to execute a Survey of considerable magnitude.

Having established a base, measured it from each end, and made observations of all the best stations you can fix upon in the surrounding country, you may proceed to cut up the work into secondary triangles,

and then to "take up" the principal streams, roads, or some other marked or well-defined lines of considerable length, such as embankments which occasionally occur, the boundaries of woods, &c. The streams and roads are very important; the former indicate to a great extent the direction of the main ridges of hills, running for the most part parallel to or at right angles to the water-shed lines; and they are, in a military point of view, of the utmost importance, constituting frequently the most formidable of obstacles, as well as at other times our chief natural auxiliaries. Roads, too, are of the utmost importance; and where roads and streams intersect, the need of careful survey, observations, and notes is doubled and trebled, as there will in all probability be fords or bridges. As regards bridges, as their construction is often peculiar, the most precise note must be made of their strength, durability, &c., and also as to their size and width, as in the latter particular they are so often inferior to the average width of roads communicating thereto; and this circumstance may occasion delay, difficulty, and danger on the march. The inclination of roads, their metalling, or other formation, as well as width and condition, are highly important. Be careful, then, about your roads and streams; and I must add large woods, or woods in the vicinity of roads and the line of march. In ordinary surveying, the course of these lines is determined by "traversing"—*i.e.* the course being out of one direct line, it is followed in its turnings and windings by zig-zag lines, each straight in itself, which run and fit into the bends of the rivers or roads. The length of zig-zags is determined by measurement; their inclination, by angles. Undulations of Ground next claim consideration; and, indeed, from the fact of our being often provided beforehand with maps showing the general character of the country through which we may be marching, it has been usual to consider military sketching as embracing principally a delineation of the hills and commands of ground.

Many plans omit all delineation of irregular surface. Hill-sketching is, however, very important. It will change a flat, tame-looking *plan* into something like a *model.* The object of hill-sketching is to bring up the white, or flat, surface of the paper into a heaving mass like the ground itself.

The basis of representation is this: A *system of contour lines*, being the plan of the intersections of various horizontal planes with the natural slopes of hills. To exemplify this: Take a model of ground, put it into a water-tight box or case, pour in coloured water to a certain depth; the water-edge marked all round the model gives a horizontal contour. Add more water, and you get a contour of greater altitude, and so on. Thus you may see how horizontal planes would intersect the natural undulations of ground. These contour lines are traced on the ground by levelling instruments. This is the true basis of all good hill-sketching; because you not only arrive thereby at the exact height of hills, but you reach that point step by step, and thus note the varying slopes that go to make that total altitude. If all hills were conical, perfect cones, or of the shape of other mathematical figures, we might deduce their heights by base and angular measurement; but natural hills vary totally in form, and their sections show, first, one kind of slope, then another. A system of contours, then, is best; for these lines will embrace the whole circum-

ference of rising grounds, while mere lines of levels, run up and down on various sectional lines, show only the inequalities of the surface on such particular lines. This system also enables us to construct sections in any direction—useful for a variety of purposes—from the map alone, when the contours have been carefully plotted and figured to denote the differences of altitude. Instances of the great value of such maps may be found by reference to provincial works—the laying-out of railways, and the critical examination of country with a view to constructing reservoirs of water for large towns, where it is requisite to ascertain, in the first instance, when water has to be brought from a great distance, what undulations of ground intervene, and the various difficulties that present themselves. Railway engineers are often obliged to go and look over the ground, and take trial lines, in order to find out the change of levels; but, if they had a contour plan like the Ordnance maps, they can do it at once—they can sit down in their own offices, and make trial lines perfectly accurate. They have done so on many occasions. I remember when I was on the survey of Yorkshire, in a very wild and sequestered part, behind Skipton, to the north-west of Leeds and Bradford, I came upon a large number of navvies working. There was evidently some very large work going on. I stopped to find out what it was. There was a beautiful natural amphitheatre of hills on all sides, ranging up to four and five hundred feet above a piece of level ground. When I inquired what was going on, they said the place had been selected, from its peculiar formation, for collecting the water from the hills, and that the water was actually to be carried down as a water-supply to Bradford, or some such place many miles off. Well, it appeared that our Ordnance Survey, with the contour lines extending over a space of eighteen or nineteen miles, had saved the engineers the trouble of actually carrying their levels over that considerable tract of country—a work which would have occupied six or eight weeks, and involved great expense. They just had to walk into a stationer's shop and buy these Ordnance maps, to find out exactly the difference of altitude above the sea, of the place where they proposed to collect the water, and of Bradford, whither they intended to take it. They could also get the height of the hills that intervened, and could form an opinion as to the comparative cost and trouble between cutting tunnels and leading the channel round by the foot of the hills. All this preliminary work they were saved by the expenditure of a few shillings on an Ordnance map. I bring this instance forward as a proof of the value of contour lines. Such a contoured map is *almost* complete—*incomplete* as regards the *character* of the natural features, a term which may include a strictly geological definition of the ground, or simply such distinctive appearance as the most casual observer would naturally recognise. This character has to be brought out by clever sketching; it affords scope for considerable skill. The sketching consists in seizing marked, distinctive features, and portraying them with fidelity and spirit, heightening the effect of the representation on paper, just in proportion as these marked characteristics heighten the effect in nature; and it will give, if well managed, at once the geological structure of the country. This sketching—first in pencil—is etched in short horizontal strokes, interpolated between the longer or general

contour lines. It must be seen to be understood, and should be carefully practised on the system of the Ordnance Survey, which was originated, advanced, and most successfully carried on by the late Mr. Dawson. (The Lecturer here exhibited several specimens of the Ordnance Survey Maps.)

This, then, is the Ordnance system. It is most accurate, and the effect admirable. The French system is rather different; they interpolate vertical *hâchures* between their horizontal contours; the effect is *bad* generally—very wooden and ugly, giving a prominence and implied existence to the simply theoretical contours, and consequenty destroying the salient prominence of real and striking natural and geological lines which affect the whole picture so wonderfully.

This part of my subject has long been a very vexed question amongst *savans* and our own practical surveyors. Volumes of "Blue book" have been written about it, and I cannot hope to have brought it before you in few words with much effect; but with the beautiful examples of our Ordnance Survey before you, and opportunities of comparing the same with the result of every other known or tried method, I do not fear but you will give the palm to our British work, and agree with me that it is most desirable that officers generally should adopt the same principles of *horizontal* sketching, and so greatly increase the value of their independent labours, which may then be conveniently massed and filled together when occasion requires.

The foreign plans now before us show another point of difference that has hitherto existed between us, but we are now wisely following in the wake of continental nations in this respect. I allude to the mode of inscribing or attaching "scales" to plans. We always used to adopt a scale of (say six) *inches to the mile;* but if you take up any continental plan you will see the scale marked $\frac{1}{1000}$ or $\frac{1}{10000}$, and so forth. That represents the proportion of 1 to 1000. It means one inch, one yard, one mile, or anything you like as an unit on paper, with reference to one thousand times that unit on the ground.

The chief recommendation of these "natural" scales is, that they may be constructed in terms of any unit most convenient to the person using it. I will take the easiest illustration I can give :—

Take the scale of one inch to a mile, which means an inch on paper as equivalent to a mile on the ground. This may be written $\frac{1}{63360}$; for, reduce the mile to inches—

$$\begin{array}{r} 1{,}760 \text{ yards} \\ 3 \\ \hline 5{,}280 \text{ feet} \\ 12 \\ \hline 63{,}360 \text{ inches}; \end{array}$$

then you get one inch on paper is equal to 63,360 inches on the ground, and the fraction is expressed $\frac{1}{63360}$. That explains how these "natural" scales are used. Any one can take up these plans and use them, adopting the unit peculiar to his own nation. The natural scale at once establishes the relation between the paper and the ground. The large scale of the

Ordnance Survey is $\frac{1}{2500}$; it is also that upon which the *cadastres* of France, Bavaria, of Wurtemberg, and of other continental countries, are originally mapped. It is an admirable scale, large enough to facilitate registrations, conveyances, and other matters fiscal and political, &c. &c. and it is particularly well adapted for quick computations of areas, as a square inch of map on this scale as nearly as possible represents an acre. The scales hitherto mostly used for military surveys are the 1″, 4″, or 8″ to a mile.

The 1″ gives a fair general map (2″ is better);

The 4″ gives district map;

The 8″, and above that, maps whereon to mark or lay out positions, forts, and other special surveys.

Having recommended the beginner to survey on the correct principles of triangulation, traversing, detail work, and hill sketching, all of which he can easily master by aid of various works published, some of which are written in the plainest terms, while others give more extended information on the higher branches of surveying, such as astronomical and mathematical questions, and recommending him also to put in *practice* what he learns, to an extent that will gradually educate him to accuracy, method, and confidence in his work, I will now suppose him thus far a good workman; and I now, but not till now, insist upon the great value of speed on matters of military survey.

It is so highly important, that, although it is self-evident that no plan can be good or useful if incorrect, yet some of our best authorities rank speed in preparing military plans above all else. Now speed is promoted by a thorough knowledge of your subject; by previous careful work and training; don't attempt it till you have become a good workman. Let all your plan, all the information you have to give, be set forth in a clear, intelligible form and compass. Never overcrowd your Plan with petty details, neither be diffuse in your Reports; a good military plan and report should in this respect be like a leading article in the "Times," giving the pith and marrow of the subject, and eliminating what (though true enough) is not wanted, and presenting the whole subject in clear, intelligible language, whether of pen or pencil. To this end we agree with our continental neighbours in delineating "military reconnaissances" in characters as highly suggestive as possible. If you look at an engraved map, you will find everything in black and white—the general effect is thus preserved; but in reconnoitring sketches, various colours are used, destroying perhaps the unity of effect and beauty of the map, but greatly facilitating a rapid comprehension of its details. At a glance the water-courses present themselves, high roads stand out from byeways, strong stone houses are not confounded with mere wooden sheds which would afford no permanent cover or protection, bridges of stone are distinguished from more simple and frail structures, Woods, pasture, corn-growing districts—all have their distinctive colours and marks.

The mode of writing up these plans should also be attended to. Let the "top" of the plan be in direction of the enemy—usually we make the north the top of our *maps;* write your names of districts, towns, and villages in size proportionate to their respective importance; keep mainly to the sloping or italic style, because it is much the easiest and

speediest; your headings of plans, and such like writing requiring a large character, may be shown thus, "**PLAN**"—square block printing. These hints you will find useful in economising time and labour; and, in furtherance of the same most important points, let me advise you, before starting on your day's work, or sitting down to any work of magnitude, to see that you have all things ready to your hand. We have endeavoured to improve on the sketching cases hitherto in use. It is very desirable that an officer should have about him everything in the way of paper, pencils, colours, knife, &c. &c. which he may be likely to require in making plans and reports; at the same time he should be as little incommoded as possible by bulk and weight.

The case we now use has the following advantages: A place for everything, and everything in its place; lightness and portability; capability of supporting and keeping extended a plan *double* its own size; a convenience of use on horseback, the case being firmly supported in front of the body while the bridle hand is perfectly free. The case will hold either a "block," as used at Addiscombe, or the bank post paper used at Woolwich and Chatham, and is equally well adapted for both. It will carry foolscap for Reports; colours, scales, knife, &c. &c., and when filled will not weigh more than the old case empty. It may be slung to the sword-belt, inside a sabretache, or over the shoulder in a sort of waterproof havresac; and so you have either a "parade" or "active service" equipment at pleasure.

I may conclude this subject by saying, that it would be indeed a great pity to exclude from Staff employ an officer gifted with considerable talents of various kinds, but without neatness of hand and taste for drawing. Yet many officers, feeling a natural deficiency in these respects, may, under existing regulations, be discouraged from attempting to qualify themselves for Staff appointments. Now, it is not possible to make an *artist* of every man you meet; but every man may be taught to make a clear, serviceable sketch or plan, and to read and understand one as easily as he can a letter. Let none despair of mastering so simple an art as Military Surveying!

The following Works are recommended to Students:—

Jackson's Military Surveying.
Frome's do. do.
Drayson's do. do.
Burr's Military Sketching.
The "Aide-Mémoire" and Professional Papers, Royal Engineers.
The R. E. Corps Papers, embracing Colonel Robinson's Report on the North American Boundary, and other Reports.
Field Operations. By Major Jervis, R.A.
Traité sur la Reconnaissance. By De Chatelain.
Ditto ditto. By L'Espinasse.
&c. &c. &c.

Friday, March 8th, 1861.

THE RIGHT HONOURABLE LORD LOVAINE, M.P. in the Chair.

MILITARY TRAINING

CONSIDERED PRINCIPALLY WITH REFERENCE TO THE MEASURES ADAPTED FOR THE DEVELOPMENT OF INDIVIDUAL EXCELLENCE.*

BY

LIEUT.-COL. A. CUNNINGHAM ROBERTSON, 8th (The King's) Regiment.

The subject of the address which I am about to read is of considerable practical importance, and I venture to hope that the discussion of it in this place may possibly lead to beneficial results.

If any of the suggestions which I shall have the honour of submitting to you be true in principle, and practically expedient, there are members belonging to this Royal Institution who have both the will and the power effectually to promote the adoption of any measure which may, in their judgment, be calculated to improve the efficiency of our military institutions.

But the utility of discussing such a subject as military training is, to a certain extent, independent of the correctness or incorrectness of any particular conclusion.

Even although the considerations which I am about to submit to you may not be sufficient to prove that any specific measure is expedient, yet these considerations will not be altogether destitute of value if they suffice to attract your attention to a particular aspect of the subject of military training, and if they tend to show that, in order to render the training process effective, we must endeavour to render it interesting and attractive.

The efficiency of the training of an army depends—

1st. Upon its comprehending provisions for the attainment of every species of knowledge and of every species of skill susceptible of a useful military application.

2nd. Upon the excellence of the methods of instruction made use of.

3rd. Upon the amount of time and energy which the officers and soldiers composing the army can be compelled or induced to devote to the work of instruction.

It is principally to the third of these three essential conditions of a complete system of military training that I am at present anxious to direct your attention.

I shall endeavour to present to you, with as much fulness as the time at my disposal will permit, an exposition of those means which, it appears to

* Several extracts from an article contributed by the author to Colburn's United Service Magazine in November, 1856, are incorporated in this paper.

me, are likely to operate most efficaciously in inducing the officers and soldiers of an army to devote to the work of training that amount of time and energy which it is indispensably necessary should be devoted to that work, in order to secure the development of individual excellence.

But before entering upon this exposition, it will be convenient to say a few words regarding the nature of the objects of military training, and the principles that must determine the selection of the means which are appropriate for the attainment of these objects.

The question—What is the object of military training? may perhaps be most perspicuously answered by changing its form, and asking what qualifications are desirable for the perfect performance of the duties of the different military grades?

Bravery, strength, agility, habits of obedience and temperance, skill in the use of arms, expertness in drill and in the various exercises, operations, and processes incident to service in the field,—these are the qualities, the possession of which constitute a thoroughly efficient private soldier; to which must be added, if he belongs to the cavalry branch of the service, a perfect knowledge of all that relates to the management of horses.

In addition to these, a non-commissioned officer should possess the rudiments of education. He should possess a sound knowledge of reading, writing, arithmetic, and book-keeping.

Ascending to the next grade: firmness, energy of character, equanimity of temper, skill in horsemanship, a thorough familiarity with the principles and special provisions of military law, and with the rules and regulations of military service, together with an elementary knowledge of the sciences of artillery, fortification, military history, military geography and tactics, are the additional qualifications necessary to constitute an accomplished regimental officer.

Attainments, the same in kind, but superior in degree, are those which it is desirable should be possessed by staff officers and officers of the corps of Engineers.

An officer selected for either of these special services should be thoroughly acquainted with the principles and familiar with the practical applications of the sciences of artillery, fortification, and military engineering.

He should have attentively studied the history of the principal modern campaigns, and should be well acquainted with the military geography of the countries which were the theatres of those campaigns. He should be master of the special tactics of cavalry, infantry, and artillery, and of the theory of strategy and general tactics. He should be a clever draughtsman, an expert surveyor, and so good a linguist as to be able to speak and write fluently the principal modern languages, and to be able to acquire with facility a colloquial knowledge of any other dialect which may be spoken in the country in which he is serving.

Finally, let us suppose an officer who, possessing many of the attainments and all the qualities desirable for the performance of all the duties of the staff with perfect efficiency, shall also be pre-eminent for the firmness, the energy, the self-reliance, and the resolute boldness of his character; for a penetrating sagacity quick to detect the designs of an enemy, and for inventive faculties ever ready to devise skilful combinations, and to arrange

well-digested plans. In a word, let us suppose military genius to be united to military science, and we have the perfect model, the *beau idéal* of an accomplished general.

All the particulars of this detailed enumeration of the qualifications desirable for the perfect performance of the duties of the different military grades are comprehended in the general statement, that the two great objects of military training, are—

First. To impart to the individual officer, and to the individual soldier, whatever qualities, whatever kinds of knowledge, and whatever species of skill, are necessary to enable him to fulfil every function of his grade in a perfect manner.

Second. To instruct soldiers and officers collectively in regular systematic modes of performing all exercises, operations, and processes which are necessary for the purposes of offensive or defensive warfare, or which are conducive to the comfort and efficiency of troops employed in field service.

The objects of the processes of individual and of collective training, though perfectly compatible with one another, are essentially different in their nature.

Each object requires for its attainment the use of certain specific means, and, as will be afterwards shown, the means appropriate for the attainment of the object of individual training are radically different in principle and in their manner of operation for their attainment of the object of the processes of collective training.

In a perfect system of training, suitable provision will be made for the attainment of both objects; and if either be neglected, the troops will, in certain respects, be inefficient and imperfectly fitted for the purposes of war.

In the middle ages we have an example of a system in which individual training was carefully practised, and collective training altogether neglected.

The many interesting and exciting circumstances attending the celebration of tournaments, the wide-spread renown, the high personal distinction, the favour of the fair, and the admiration of the brave, which were the rewards of the victors in those splendid trials of skill, were means admirably fitted to fill the ranks of the mediæval armies with soldiers thoroughly accomplished in the use of their arms, and skilful in every warlike exercise.

But these soldiers, individually terrible in battle, were destitute of that collective training necessary to render them proportionably formidable when acting in masses, necessary to render the results such soldiers were capable of achieving proportional to the numbers employed.

The modern method of training armies, introduced by the great Frederick, furnishes an example of a system precisely opposite to that of the middle ages.

In this system, the sole object aimed at is to regulate the movements of masses of troops with mathematical precision.

Individual training, except in so far as it is subservient to collective training, is altogether neglected.

The recruit, after going through a process of setting-up drill, and being taught how to face in whatever direction he may be ordered, is very carefully trained so to regulate the length and quickness of his pace as to be able to march steadily at a perfectly uniform rate of motion.

He is also taught to go through the manual and platoon exercises.

This, previous to the Crimean war, was the whole amount of individual training bestowed on our infantry soldiers.

To develope individual excellence, or in any way to turn to account the special endowments or acquirements of the infantry soldier, was not, either directly or indirectly, the object of this training.

Its sole object was to ensure precision and uniformity in the subsequent processes of collective training.

It may, perhaps, be said that the annual ball practice had a different object; but though ball practice was no doubt intended to train men to hit the mark, that is, to use their arms skilfully, it was so conducted as to be quite incapable of producing any effect as a means for obtaining this end.

In the year 1844, when quartered in Dublin, I have known a regiment march down to the sands at the Pigeon House, and expend, in a single day, the whole of the season's allowance of practice ammunition, which was got rid of principally by firing volleys into the sea.

Previously to the adoption of the Hythe system of musketry instruction, ball firing was practically nothing more than the last lesson in the platoon exercise. It taught the recruit to load, and accustomed him to the recoil of a ball cartridge. This was all it actually did. This was all that, in the nature of things, it was capable of doing.

To find an example of a system in which due provision was made both for individual and collective training, we must go back to the military institutions of the Romans.

In the time of Julius Cæsar the admirable legions of that great military power were perhaps the most perfectly trained and the most formidable troops ever employed in warfare.

Not only were these legions collectively instructed in all the processes necessary for the accurate formation of the line of battle, and for enabling its position or direction to be changed with the utmost possible rapidity, but the personal qualities of each individual legionary soldier, his bodily vigour, and his expertness in the use of his arms, were carefully cultivated by the assiduous practice of appropriate methods of training.

The Romans did not consider it sufficient that their soldiers should excel in that training which enables the united efforts of the feeble to overcome the separate efforts of the strong, which makes a disciplined band of pigmies more than a match for an undisciplined mob of giants; they were also solicitous so to train their soldiers that each individual soldier, when acting by himself, should feel himself superior to his adversary.*

Since the time of Frederick, to render the soldier individually superior to his adversaries has not been an object of military training in European armies.

Regularly trained European soldiers when acting together in masses are formidable, but those regular troops who defeated the Highland clans at Culloden, or the Mamelukes at the Pyramids, would, generally speaking, have felt themselves no match for their adversaries in individual combats.

There can be no stronger proof of the excellence and of the great

* In No. 12, vol. iv. of the Journal of the Institution will be found an interesting sketch of the military institutions of the Romans.

importance of collective training, than the well-ascertained fact that regular troops are able to contend successfully against adversaries superior to them both in numbers and in personal qualities.

But although the conditions of modern warfare are such, the completeness of the collective training of troops is a more important element of success than the perfection of their individual training, yet it would be a very great mistake to suppose that personal qualities have little or no influence in modern warfare, and that the development of individual excellence by appropriate training processes will have little or no influence in increasing the efficiency of an army.

In studying the circumstances of such combats as Culloden or the Pyramids, the point on which it is profitable to fix our attention is not on the results which follow when two bodies of troops contend, one of which is deficient in collective and the other in individual training, but on the results which might be expected to be obtained by troops equally perfect in both kinds of training if matched against adversaries inferior to them in either the one or the other of those kinds.

The individual training of the private infantry soldier should embrace instruction in—

1st. Marching and setting-up drill.

2nd. In gymnastic exercises, including swimming.

3rd. In the use of his arms and of entrenching tools.

4th. In field cookery.

His collective training should embrace instruction—

1st. In field exercises and evolutions.

2nd. In heavy gun drill and in the management of artillery.

3rd. In the method of constructing trenches and batteries in presence of an enemy.

4th. In escalading.

5th. In the method of pitching tents and constructing huts.

6th. In the method of using tackles, and in the modes of applying some of the simpler mechanical contrivances for moving heavy bodies.

In addition to all that is taught the private soldier, the training of officers ought to include regular and systematic instruction—

1st. In the regulations of military service.

2nd. In military law.

3rd. In the method of tracing field works, and of distributing working parties.

4th. In the method of attacking and defending posts, and of conducting the various minor operations of warfare.

I imagine there would be no difficulty whatever in devising inexpensive arrangements for habitually exercising infantry soldiers in every process and operation which forms part of the regular training of a gunner belonging to a reserve company of artillery.

I do not, however, forget that the special training of the sapper is a costly process, and one which cannot be carried on excepting under conditions which it would be impossible to fulfil, and with appliances which it would be impossible to procure, at many stations where infantry are quartered.

But although some of the processes in which the sapper is instructed

could not be taught at all to the infantry soldier, and although others could not be taught by the same methods and in the same complete manner in which they are taught to the sapper; yet I feel sure there are many engineer officers (say, Col. Harness or Lieut.-Col. Bainbrigge) who could organise a system of instruction in the method of using tools, tackles, and simple machines, and in the most effective means of applying combined labour to produce specific results, suitable to the opportunities for instruction afforded by the ordinary conditions of the service of an infantry soldier.

In order to provide men qualified to act as instructors to train the soldiers to labour, and as overseers to direct and superintend their work when actually employed in any manual operation, a regularly trained sapper might be attached to each company in the capacity of pioneer.

Officers who had passed through the Staff College, when not holding Staff appointments, might also be advantageously employed as agents for carrying out any system that might be devised for exercising infantry soldiers in some of those processes which at present form part of the specialities of the training of the sappers.

The state, which maintains during peace, at a vast expense, a great body of men whose sole occupation is to render themselves fit for the purposes of warfare, has a right to expect that the training of these costly servants shall be not only more perfect in degree, but also more comprehensive in its scope, than the instruction hurriedly given to militiamen, raised for temporary service.

It has a right to expect that the term "regular soldier" shall denote not merely an unskilled labourer wearing a particular uniform, but a man who, having undergone a long apprenticeship, is accomplished in every species of knowledge and every species of skill which has any special practical relation to the varied exigencies of military service, who has been sedulously trained in all arts which render a man formidable in battle, who has been carefully instructed in all expedients which enable him to overcome the difficulties and efficiently to assist in the labours of a campaign.

I have now stated what I conceive ought to be the objects of military training. The means available for the attainment of these objects are,—

1st. Systematic collective instruction.

2nd. The independent prosecution of military studies, and practice of military exercises by individuals.

Whatever kinds of knowledge and whatever kinds of skill it is essential that every officer or every soldier should possess for the efficient performance of the ordinary functions of his grade, ought to be communicated by regular systematic instruction.

The acquisition of those kinds of knowledge and skill which are only applicable in special circumstances, and which it is only necessary that a certain proportion of the officers or soldiers of an army should possess, need not be made imperative on any one.

It is not necessary to make the acquisition of reading and writing imperative on every soldier, or the acquisition of mathematics and of the military sciences imperative on every officer of an army.

Provided some special emolument or distinction be conferred on all who possess special attainments, it may be left to the discretion of each indivi-

dual to determine both the number and degree of the acquirements of this kind which he shall possess, and also to determine what particular means, and what amount of exertion, are necessary for the attainment of his object.

Having thus indicated a general principle, which will serve to determine the nature of the means which are suitable for the attainment of the different objects of military training, I shall not attempt to enter into any details respecting the specialities of different processes of instruction, but I beg to refer to the paper which was read in this place in June last, by Captain Jervois.* It contains very interesting statements regarding the results of gymnastic training in continental armies, and points out very simple arrangements by which gymnastic training might be carried out, not only in barracks and permanent camps, but even in the field.

In confirmation of Captain Jervois' opinion, that it is practicable to carry on gymnastic training, even during the operations of a campaign, I may mention that during the recent Indian campaign the engineer officers attached to Sir Thomas Seton's column carried about with them posts and bars. At almost every halt these were set up, as soon after the morning's march as the tents were pitched; and in the evening these officers used to amuse themselves by practising gymnastic exercises.

The next point to be considered is the means by which the officers and privates of an army may be induced to devote their time and energies to the work of instruction.

These means are,—

1st. The infliction of penalties.

2nd. The distribution of rewards.

Either of these means may be employed by itself, or the two may be combined.

In the category of penalties must be included, not only the ordinary punishments inflicted on soldiers for the careless performance of prescribed exercises, but also all regulations making the promotion of officers and non-commissioned officers contingent on their possessing certain prescribed qualifications.

In order to form a correct opinion as to whether it is sufficient to enforce the use of any particular training process by compulsory means, or whether, either instead of or in addition to such means, those inducements should be also employed which are adapted to stimulate voluntary exertion, regard must be had to the nature of the result which that particular process is intended to produce.

In some training processes the result sought is, that all who are instructed should attain precisely the same uniform degree of average proficiency. In others, that each separate individual should attain the highest degree of excellence of which he is capable.

If only ten men of a company one hundred strong can be trained to become first-rate marksmen, it is very desirable that these ten men should be made as perfect as possible, without any reference whatever to the degree of skill which it may be practicable to impart to the remaining ninety. But if one hundred men of a regiment one thousand strong could be taught to execute six manœuvres, while the remaining nine hundred could only be made to comprehend the method of executing four, the superior knowledge

* See Vol. IV. page 376.

of the first hundred would be of no use until the same amount of instruction could be conveyed to all the other soldiers. Nor, in performing field exercises, would any advantage whatever be gained by training a certain percentage of the men of a regiment to march at a rate considerably quicker than that of the regulation pace, unless it were found practicable to train every other soldier of the battalion to march steadily at the same accelerated rate.

These illustrations will suffice to show what I mean, when I say that the objects of individual and of collective training are different; that in the one, excellence—in the other, uniformity—is the result sought.

In those processes in which uniformity is the essential object to be attained, it is obvious that all differences of individual power are injurious, and that the use of those means which are calculated to stimulate voluntary exertion and to develope individual excellence can have no place.

In those processes, on the other hand, in which the utmost possible degree of individual excellence is the result which we desire to obtain, it is essential that the methods of instruction should be rendered as attractive as possible, and that, by the use of appropriate means, the desire to excel should be generally diffused among those who are to be instructed.

As a necessary condition for the general diffusion of a desire to excel, provision must be made for discriminating different degrees of acquirement, and for making special advantages contingent on the attainment of the higher degrees.

The efficiency and fitness of any system of training for the development of individual excellence, will, therefore, mainly depend on the efficacy of the means employed to excite and diffuse the desire to excel.

If those parts of military training, which admit of the discrimination of degrees of acquirement, are ever generally regarded by soldiers with disgust, as an irksome drudgery, this state of feeling may be accepted as a conclusive proof that the system of training is defective, and that proper provision has not been made for giving soldiers a beneficial interest in successful exertion.

Until very recently, when on the substitution of rifles for muskets in the armament of infantry, the classification of soldiers, according to their skill as marksmen, was adopted as part of the admirable method of musketry instruction organised by General Hay, our system of military training was entirely compulsory in principle.

It contained no provision for discriminating degrees of any one of the various acquirements which it is desirable that soldiers should possess, nor did it contain the vestige of any other provision calculated to favour the development of any kind of individual excellence.

In each of the grades of the military organisation, from the grade of the drummer to that of the general, the sole object aimed at was to communicate a certain minimum of such kinds of instruction as were absolutely indispensable to all who performed the functions of that grade.

The system took no account whatever of those inherent differences of capacity and energy, or of those various degrees of acquirement, which distinguish man from man.

Talent was not rewarded; zeal was not encouraged; precise systematic uniformity was reckoned the one essential object; implicit obedience the one essential condition of successful training.

In order to estimate what amount of efficiency is likely to be the result of a system of training which contains no provision for creating a desire to excel, which offer to individuals no inducement to strive after excellence, let any one consider what would be the effect on the learned professions if the influence of individual exertion in procuring the honours and emoluments of these professions ceased when the young barrister obtained his gown, or the young physician his diploma: if the bench ceased to be the prize of superior legal ability, if riches and social eminence were no longer the reward of superior medical skill: or, since the ability of the soldier cannot in time of peace be manifested by successfully contending with the practical difficulties of military service, but, like the aptitude of a young man to succeed in life, can only be imperfectly measured by the completeness of his preparatory training, let us choose an illustration more strictly analogous, and consider how learning would thrive in our schools and universities, if the distinction of academical honours and advantages of academical endowments ceased to stimulate students to use their utmost exertions for the acquisition of learning.

If, then, experience proves that to make honours and emoluments the reward of excellence is a means which it is necessary to employ in order to produce able lawyers, skilful physician's, and accomplished scholars, surely it is reasonable to infer that we must employ means of the same kind if we wish to produce well-trained soldiers.

I think no one would deny that this inference is reasonable, were it not that the highest kinds of military merit are of such a nature that in time of peace it is not only impossible to measure their degree, but it is not even possible to ascertain their existence with certainty.

Courage is the highest merit of a soldier. Courage, firmness of purpose, energy of character, natural sagacity, and inventive genius are the highest merits of an officer. But these qualities can only be made manifest in time of war, when occasions arise for their exercise. How, then, some may argue, is it possible to discriminate the degrees of merit existing among the individuals of an army? How is it possible to apply the principle of developing individual excellence to a system of military training?

It would indeed be impossible to do so, if no qualities possessed military value excepting those which must necessarily remain latent during peace, or if, in order to reward an individual for well-ascertained excellence of a particular kind, it were indispensably necessary to ascertain that he was endowed in an eminent degree with some other quality, the existence or non-existence of which we did not possess the means of discovering.

But besides courage, are not strength, agility, skill in the use of arms, qualities which are necessary to constitute a good soldier?

Besides military genius, is not knowledge of the military sciences, and skill in the practice of military arts and exercises, necessary to constitute an accomplished officer? Are not these qualities of a nature to be at all times, in peace as well as in war, patent to observation?

As exhibited in different individuals do they not all admit of differences of degree, and may not these differences be measured with tolerable accuracy?

It is, indeed, very probable that the best shot in a company might not be the bravest soldier—that the most scientific officer in a regiment might

not be endowed in the same degree with energy, prudence, and the inventive faculties.

But though it may be exceedingly difficult, or, let us rather say, absolutely impossible, before troops have gone through the ordeal of warfare, to determine absolutely who is the best soldier in a company, who is the best officer of a regiment, or who the best general of an army, surely this is no reason why we should not reward superiority in any particular quality which it is advantageous that every soldier, every regimental officer, or every general should possess—wherein it is desirable that every individual of every one of these ranks should use his utmost efforts to excel.

These considerations seem to me sufficient to show that the old system of training by methods exclusively compulsory was defective, and to render it extremely probable that the efficiency of the training of the army might be greatly increased by the adoption of measures based on this fundamental principle, *that it is expedient to confer some special advantage, either pecuniary or honorary, on every individual, whether officer or soldier, who attains a certain degree of proficiency in any art, exercise, or science susceptible of a useful military application, and in which it is desirable that each individual should endeavour to excel.*

In considering what particular measures are best fitted to give practical effect to this principle, regard must of course be had to the different degrees of importance which attach to the various qualities, arts, exercises, and sciences which it is the end of military training to develope or to teach.

A careful estimate must also be made of the manner in which the working of any proposed measure is likely to be affected by the other provisions of our existing military institutions. We must consider whether the interests which are the result of those provisions are likely to favour or likely to oppose the smooth working of the measure.

Since the invention of gunpowder was effectively applied in warfare, great battles have generally been decided without actual collision between any considerable masses of the infantry of the hostile armies; and the recent improvements in the construction of fire-arms have greatly increased the distance at which infantry can fire with precision, and consequently act with effect.

To render the infantry soldier a good marksman, ought therefore undoubtedly to be considered the primary object of his individual training.

The classification of soldiers according to their skill as marksmen, which forms so prominent a feature in the new system of musketry instruction, appears to me the most efficacious means which it is possible to devise for promoting this object.

It is a measure which has completely altered the character of military training.

Formerly, the process of training a soldier merely consisted in compelling him to practise daily for a certain number of hours a regulated mechanical routine; now, this process has become the acquisition of an art requiring the exercise of the soldier's intelligence and the co-operation of the soldier's will. Formerly it was an irksome drudgery, now it has become an interesting and profitable occupation.

This change in the nature of the soldier's training necessarily elevates his position as regards other classes of the community.

Formerly he belonged to the class of unskilled labourers, whose services receive only a uniform rate of remuneration; now he belongs to the class which practises those arts in which differences of skill command different rates of wages. As compared with the sister service of the Royal Navy, the classification of soldiers, according to their skill as marksmen, may be regarded as according to the army that recognition of individual merit which has always been enjoyed in the navy, by the method of rating which divides the crew of a ship into the two classes of able and ordinary seamen.

The improvement in the conditions of military service effected by raising the soldier from the class of unskilled labourers to the class of craftsmen skilled in an art, is to be estimated not merely with reference to the pecuniary interests of the soldier, but chiefly with reference to the influence which this change is calculated to exert on his moral state. In order justly to appreciate the nature of the improvement, we must endeavour to estimate the moral effect of a change which opens to every soldier a career offering inducements to continual exertion, and admitting of a progress towards perfection, which, though constant, can, practically speaking, never reach a limit—a career which operates on every soldier who enters upon it by giving a salutary impulse to his apathetic feelings, a useful direction to his listless thoughts, and a profitable occupation for his idle hours.

If the administration of the Duke of York was memorable for improvements effected in the discipline and organization of the army, the administration of the present Commander-in-Chief is likely to be no less memorable for the new principle which, under the auspices of His Royal Highness, is now being introduced in our system of military training.

In the course of a few years, when experience has made us familiar with the manner in which this new principle operates, we shall gradually become thoroughly sensible of the potent influence which, when judiciously applied, it is calculated to exert on the training of troops. Improvements will, no doubt, be made in the details of existing regulations, and I think it may be expected that new measures will be devised affording additional inducements to the acquisition of military skill, and tending to increase the interest felt by officers and soldiers in the success of the training process.

I trust I shall not be reckoned presumptuous if I venture to submit to you some suggestions and conjectures respecting the additional means which, sooner or later, it may possibly be found expedient to adopt for promoting these useful objects.

An examination of the figures given in General Hay's last Report (1859-60), seems to show that the regulation restricting the number of marksmen who may be recommended for increased pay to 10 per cent. of the number instructed, is unnecessary; and that, without exceeding the prescribed limits of expense, every soldier might be recommended for increased pay who scores the number of points and fulfils the other conditions which entitle him to be classed as a marksman.

From the data given at page 41 of the Report, it appears that—

The number of men exercised was	99,019
Ten per cent. of this number would be	9,901
But the number of qualified marksmen only amounted to about three and a half per cent. of the number instructed .	3,322
Out of the number qualified there were recommended for increased rates of pay	3,200

The remainder were ineligible because, in a few particular corps, the number of marksmen exceeded ten per cent. of the number instructed; the number of men thus rendered ineligible was about 3·6 per cent. of the number qualified.	122
The amount of extra pay recommended in the Report is .	£6,348 19 0
Which is equivalent to an allowance for each man instructed of about	0 1 3
Had ten per cent. of the number instructed been recommended for increased rates of pay, the sum required would have been equivalent to an allowance for each man instructed of	0 3 6

This, then, is the anomalous result presented by the report of the year's practice; the number of men qualified to be recommended for an increased rate of pay is much less than ten per cent. of the number exercised, and yet the number actually recommended is considerably less than the number qualified.

In the present state of the instruction of the army, it is therefore evident that the regulation restricting the grant of increased pay to a certain percentage of the number instructed, if it be merely intended to act as a limit to expenditure, is unnecessary.

This end is practically secured by the high standard of qualification which must be attained to entitle a soldier to be classed as a marksman.

The manner in which the restriction really acts is most injurious and unfortunate. Its direct effect is to interfere in an arbitrary manner with individual interests by depriving a certain proportion of the soldiers in a few of the most highly trained corps of those advantages to which, as far as personal merit is concerned, they have probably, in many cases, a better right than some of the men of other corps to whom these advantages are accorded.

The indirect effect of the restriction is to lessen the motives to exertion, by making those advantages, which should in every case be the certain reward of skill, in some cases to depend on arbitrary conditions altogether beyond individual control.

A restriction which is unjust to individuals, and which is an obstacle to the attainment of efficiency, without being necessary to secure economy, may be confidently pronounced to be unadvisable.

Indeed, I should esteem the restriction inexpedient, even if it were shown in a satisfactory way that the number of marksmen was likely to exceed ten per cent. of the number exercised, and that the difference between the value of the services of a good and a bad marksman was so small, that 3*s.* 6*d.* for every man instructed was the limit of the sum which could be profitably expended for the purpose of increasing the percentage of marksmen.

In distributing a fund appropriated to furnish premiums for successful exertion, whether that fund be large or small, the one principle of distribution which it is essential should be adhered to, disregarding all other considerations, is this,—That all the conditions necessary to be fulfilled in order to establish a claim to the premium should have reference to personal qualifications; that none of them should be arbitrary and depending on circumstances over which individual exertion has no control.

Whatever sum be therefore assigned as the amount not to be exceeded in

granting premiums to marksmen, I should consider it a better provision for limiting the expenditure, to raise the qualification, than to restrict the number eligible for premiums to a certain percentage of the number instructed, thereby rendering liable to exclusion some of those who had fulfilled all the conditions which had reference to their personal qualifications.

At Hythe, where most of those instructed are picked men, and where the training process is carried on under the most favourable conditions, the proportion of marksmen to the number instructed among the non-commissioned officers and privates is only 10⅓ per cent.* It is not, I imagine, likely that the average results of the regimental practice of the army will ever be so good as those obtained at the school of instruction.

Supposing, however, the general training of the army was so much improved, that more than ten per cent. of the number trained scored 7 points in the first class, I think it would be better to raise the qualifications of a marksman to 8 or 9 points, than to exclude a certain number of those who were able to score seven points from the advantages given to others who possessed no higher qualification.

The liability of the annual course of instruction to be interrupted before all the practices are completed, or to be rendered imperfect by being conducted at places where the full extent of range is not to be obtained, are other circumstances over which the soldier has no control, which affect his chance of obtaining a musketry premium.

However skilful he may be, one or other of these contingencies may prevent the possibility of his obtaining the increased rate of pay, or, if he has already obtained it, may prevent his keeping it for more than a single season.

In the regiment to which I belong, in two successive seasons, both times after the men had worked hard, and gone through a great part of the practices, it unfortunately happened that the course of instruction was unavoidably interrupted, and the men were twice disappointed of those rewards, the hope of obtaining which had been a source of much interest and excitement.

The disappointment occasioned considerable irritation and dissatisfaction. One man, in particular, who volunteered to remain in India when the regiment was ordered home, came to the orderly room and urged that his right to a premium should be registered as an unsettled claim.

I cannot help fearing that the remembrance of these two seasons of disappointed exertion will have a tendency to render the men careless and apathetic, and that for some years to come the results of the practice of the regiment will not be so good as if the new system had been introduced under more favourable circumstances.

One mode in which the distribution of premiums might be rendered independent of the condition of a corps being able to complete the whole course of instruction, would be to substitute, instead of the present uniform test of qualification, a variable test, depending on the ratio of points made to shots fired, the ratio diminishing as the length of range increased.

A percentage of 100 points in the third class, of 75 points in the

* *Vide* Report, p. 5.

second class, and of 35 points in the first class, might, for instance, be established as the standard of performance which entitled a soldier to be classed as a marksman.

Or, if it be considered essential, as it is no doubt desirable, that the original test of qualification should in every case be the same, a variable test might certainly be admitted as a sufficient proof that a soldier who had once undergone the standard uniform test, and who had been classed as a marksman, was qualified to retain his rating.

It seems perfectly just and proper that all soldiers drawing extra pay on account of superior skill should be liable to the periodical repetition of the original test of qualification; but when circumstances prevent the test being repeated, it is certainly neither just nor expedient to inflict the penalty of failure, and to deprive a soldier of extra pay, whose skill, instead of having diminished, may very possibly have increased, and of which increased skill it is even possible he may be exhibiting proofs more real and conclusive than that proof of skill which is afforded by a soldier scoring 7 points in the first class at target practice.

To illustrate this, let us suppose a case which must frequently occur:—

Would it be expedient in time of war to grant a higher rate of pay to those marksmen of a regiment who remain with the depôt, and whose skill is merely exhibited at target practice, than to those with the service companies, who are displaying equal, or, very possibly, higher, degrees of skill in actual contests with the enemy?

In addition to the increased rate of pay granted at the end of the annual practice to those soldiers classed as marksmen, another measure might be adopted which would render skill at target practice, in exact proportion to its degree, in every case, a certain source of advantage to the soldier.

Small premiums for every point made might be distributed to the soldiers on parade at the conclusion of each day's practice, say, for instance, one halfpenny for ranges up to 300 yards, one penny for ranges between 300 and 600 yards, and twopence for ranges between 600 and 900 yards.

The superior influence of that which is present and sure, to that which is doubtful and remote, is more or less felt by all men; but it is felt in a very strong degree by men who, like the generality of soldiers, are deficient in moral and intellectual culture.

Most soldiers would prefer four or five shillings paid on the spot in ready money, to the promise of an allowance of a penny a-day, to commence after an interval of several months.

A given sum of money distributed day by day on parade in small payments, and in which distribution almost every one shared, would, I think, be found to have a greater effect in rendering target practice interesting, and in stimulating soldiers to use their best efforts to fire well, than a much larger sum allotted at the end of the season to increase the pay of a percentage of picked marksmen.

The worst marksman would have the same interest as the best to shoot carefully, since, when the unskilful soldier was lucky enough to make a point, it would be estimated to be of the same value, and would be recompensed by the same premium, as if fired by a soldier who never made a miss.

Taking for data the figures recording the practice of the 1st Battalion, 22nd Regiment, the best shooting battalion of the year, I calculate that the sum requisite for the payment of premiums according to the scale I have suggested, that is, one halfpenny, one penny, and twopence per point for the third, second, and first class ranges, would be about 2*s.* 3½*d.* for each man exercised in the complete annual course of instruction. This may be regarded as a maximum.

Taking for data the figures recording the practice of the 85th Regiment, which stands seventy-first in the list, showing the comparative merit of different corps, and which is therefore selected as a suitable corps for obtaining average results, I find that in the present state of the instruction of the army, the cost of distributing premiums for every hit on the scale proposed would not exceed 1*s.* 7½*d.* for every man who completes the course.

Between four and five shillings is the sum which a good marksman would receive in premiums during the season's practice.

If it be admitted to be beneficial to give soldiers a direct interest in the success of their exertions to become skilful marksmen, I think it may be presumed that a similar effect might be expected to be produced by employing similar means to influence the exertions made by commanding officers and musketry instructors to render the training of their corps as perfect as possible.

One means of giving those who have the superintendence of musketry instruction a beneficial interest in its success, would be to make a certain proportion of their pay consist of an allowance varying in amount in the same ratio as the proficiency of the corps, as shown in the practice returns.

Five pounds for every unit in the figure of merit of the corps might be allotted for distribution in certain fixed proportions between the commanding officer, the musketry instructor, and his assistants.*

In the case of the commanding officer, this variable allowance might be substituted for the three shillings per diem command money, which he at present receives.

When the practice was not carried far enough to admit of a figure of merit being established, the amount of the allowance might be regulated either by the percentage of points made to shots fired, or by reference to the practice of former seasons.

It is no doubt true, that the success of the training of a corps depends in a greater or less degree on various circumstances, over which those who have the direction of the process of instruction have little or no control.

Nevertheless, I think there can be little doubt but that one of the chief causes which produces the very great differences between the performances of different corps, which must strike every one who examines General Hay's report, is, differences in the capacity and energy which exist among officers commanding battalions and their musketry instructors.

If this be the case, to make part of the emoluments of these officers

* At this rate, when the figure of merit was 40, 40 × 5 = £200; and when the figure of merit was 30, 30 × 5 = £150—would be the amount of the sum to be distributed. This might be allotted in the proportion of three-fifths to the commanding officer, in lieu of his command money, and two-fifths to the musketry instructor and his assistants.

consist of a variable allowance, regulated in the manner I have suggested, would be a measure not merely expedient, but also perfectly equitable in principle. The possibility in any exceptional case of inflicting individual hardship, might be obviated by so adjusting the scale of the variable allowance to existing rates of pay, that, while those who received the higher rates should obtain a premium, those who received the lower should not suffer a fine.

Another measure of a wider scope, not restricted in its object to the improvement of rifle practice, but calculated to promote the efficiency of every part of the physical training of soldiers, would be the institution of periodical trials of skill, and the distribution of prizes to those among the competitors who were the most skilful in the use of their arms, or who excelled in any of those athletic exercises which are calculated to develope the qualities of agility and strength.

These periodical trials might be so organized, as to act as a most powerful stimulus both to officers and soldiers. They should be of three classes—regimental, district, and national. The regimental trials should be held annually at the head-quarters of each corps, the prizes being open to the competition of every member of the corps—of the officers as well as of the privates.

The district trials should be held annually in the principal garrisons and head-quarters of military districts both at home and abroad.

No officer or soldier of the regular forces should be permitted to contend for a prize at these district competitions, unless he had previously gained a prize at the regimental trial of a corps quartered in the garrison or district; but soldiers of the militia, and members of volunteer and local and irregular corps should also be admitted as competitors.

The national competitions should be held biennially or triennially at Windsor.

Any individual who, in the interval between two successive celebrations, had been a victor in a district competition, should have a right of competing for the national prizes; and, if a soldier of the regular army, in whatever part of the empire he might be serving, he should have the privilege of being conveyed to Windsor at the public expense.

The degree of interest which would attach to the regimental and district trials, and consequently the influence of the proposed measure as a means of increasing the efficiency of military training, would principally depend on the greater or less degree of social distinction which public opinion might confer on the winner of a prize at the national competition.

In proportion to the amount of social distinction awarded to the winner of a prize, and not in proportion to the pecuniary value of the prize itself, would be the eagerness with which prizes would be desired, and the strenuousness of the efforts made to obtain them.

Every means should therefore be used calculated to increase the *éclat* of victory, and to render the celebration of these national trials of military skill a splendid and imposing spectacle.

The prizes should be distributed by the hand of the Sovereign. The pomp of ancient heraldic observances should give dignity to the ceremonial of the distribution.

Considering the amount of local excitement caused by the exhibition of

athletic exercises at Highland or Border gatherings, and the still more lively interest felt by large classes of the community in the result of cricket matches, boat races, and volunteer rifle matches; considering also how widely the minutest details of every event are diffused by the press, and how vividly they are pourtrayed by photographic and pictorial illustrations, I think it cannot be doubted that the celebration at Windsor of national trials of military skill would attract vast assemblages of deeply interested spectators, and that, throughout the length and breadth of the land, multitudes of all classes of the community would be prepared to sympathise with the objects of their institution—multitudes who would listen with eager interest to the accounts of the contests for the various prizes, and in whose mouths the names of the victors would become familiar household words.

To be recognised as the best shot, the swiftest runner, the most expert swordsman, or the most accomplished horseman in the army, is a distinction that would be contended for not more eagerly by the private soldier than by the commissioned officer.

It is a distinction that would be appreciated not less highly in the aristocratic mansions of the metropolis, than in the humble cottages of the remote provincial hamlet.

I do not think it possible to form an exaggerated estimate of the effect which the hope of obtaining such a distinction would have on the physical training of the army.

The influence exercised by this motive would be same in kind, and perhaps not much inferior in degree, to that which operated on those heroic warriors who in ancient times contended for prizes at the Olympic games, or on the noble chivalry who, in the middle ages, eagerly pressed into the lists at tournaments to win, by the display of strength of limb and skill in arms, the love of women and the praise of men.

If almost every private who entered the ranks, if almost every officer who obtained a commission, could be induced to devote himself with ardour and perseverance to the voluntary practice of those exercises which develope the bodily powers and make men dexterous in the use of arms, can it be doubted that the result of those voluntary exertions would be the attainment of higher degrees of individual excellence, and also of a higher general average of strength, agility, and skill, than it would be possible to attain by the most rigorous system of compulsory training?

The institution of national military competitions, in addition to the beneficial effect which it might be expected to have in improving the training of the troops of the line, seems to be a measure peculiarly fitted to exercise an influence favourable to the permanence of the volunteer organisation.

The interest and excitement of trials of skill in which personal distinction is the reward of success, would be regarded by multitudes of young men as a fair equivalent for the sacrifices of time and money which are exacted from members of volunteer corps.

In time of actual war, or when the risk of war appears imminent, to secure the country from invasion is felt to be the most urgent of necessities, the most sacred of duties. In such circumstances, feelings of patriotism and a sense of personal danger are sufficient motives to induce men freely

to make whatever sacrifices of time and money may be required from them, and zealously to devote themselves to military training, however irksome or laborious the process of instruction may be.

But in times of profound peace, when no danger threatens, it appears to me a delusion to expect that volunteer corps can be kept together, and their members induced to persevere in the practice of military exercises, unless means can be devised to render these exercises attractive, and to render the fulfilment of the duties of a volunteer the means of obtaining some privilege, some advantage, or some distinction which is an object of general desire.

The sum necessary to provide an adequate prize fund for periodical competitions, arranged according to such a scheme as I have detailed, might be estimated at an allowance of

£1 per company, or about $2\frac{1}{2}d.$ per man, for the regimental competitions;

£5 per battalion, or about $1\frac{1}{2}d.$ per man, for the district; and

£10 per battalion, or about $3d.$ per man, for the national competitions: making for the prize fund of the three classes a total of about $7d.$ per man.

If all the measures which have been discussed were adopted; if, in addition to the extra pay granted to marksmen, premiums were distributed for every point made at target practice; if successful musketry instructors received increased allowances; and if prizes were awarded at periodical competitions to all who excelled in any military or athletic exercise; if, moreover, it be assumed that the effect of these measures was to make every corps in the army shoot as well as that corps shot this year which stands first in General Hay's report, the whole cost of these measures, including both the increase caused by the use of additional means, and that caused by increased efficiency, would not exceed $5s.\ 9\frac{1}{2}d.$ per man.

That is to say, the additional cost of training 62 soldiers, caused by employing such means as I have suggested, would be equal to the pay of a single soldier.

A reduction of about one and a half per cent. in the establishment would therefore provide sufficient funds for carrying out these measures without any increase of the army estimates, and I think it might be fairly expected that this small reduction in the numerical strength of our military forces would be much more than compensated by the increased efficiency which would probably result from rendering the training process as attractive as possible, and from making each individual soldier feel that he had a strong personal interest in becoming as perfect as possible in every military exercise.

I now pass on to the consideration of the measures suitable for promoting among officers the acquisition of those special attainments which require a certain degree of intellectual exertion, and which must be acquired by study in the closet.

The general principle to be observed in framing measures intended to promote voluntary study, is to leave as much latitude as possible to the exercise of individual inclination in the selection of the particular subjects to be studied—not to estimate merit solely by reference to one exclusive standard, requiring the combination of a certain number of particular

attainments, but to admit of as many different standards of merit as there are different kinds of attainments.

The value of that superior merit which consists in the union of many different attainments, is exaggerated when the circumstance of union is constituted the essential condition on which the entire value of each particular attainment exclusively depends, without the existence of which condition, any particular attainment, however perfect in degree, is to be reckoned altogether valueless. The true principle is to assign to each particular attainment a certain specific value, and, where two or more are combined, to assign to their union a cumulative value proportioned to their number.

Let the first place be assigned to him who is ignorant of nothing which an officer ought to know; but do not overlook the merit of any one who excels in a single useful speciality. Do not insist upon a good linguist being also a good mathematician. Do not refuse to reward a skilful draughtsman because he is a bad artillerist, or because he is ignorant of military history.

In addition to the provisions which at present exist for the admission of officers to the Staff College, and for the selection of officers for Staff appointments from among those who have passed satisfactory examinations in the prescribed course of college studies, it therefore seems to me that it would be highly desirable to provide: That any regimental officer, under the rank of a field officer, adjudged by a central board of examiners to be proficient in any extensively spoken living language, whether Oriental or European, or to possess in an eminent degree any other species of knowledge or skill susceptible of a useful military application, should receive increments to his daily pay, and have distinguishing letters attached to his name in the Army List, corresponding to the number and degree of his attainments.

These increments might vary from sixpence to one shilling per diem, according to the relative difficulty and importance of the attainments to be rewarded. Four or five shillings per diem might be fixed as the maximum of the aggregate increments to be awarded to any one individual.

The maximum rate should be added to the pay of all officers under the rank of field officer, and not actually holding a Staff appointment, who obtain a Staff College certificate.

All such officers should also be registered in the Army List as Staff supernumeraries, and, when not on parade, they might be permitted to wear the uniform of the Staff.

I think it quite certain that measures such as these, putting it in the power of every individual officer to earn a large addition to his pay, and also to secure for himself the distinction of being affiliated with the Staff of the army, and the contingent advantage of being nominated to honorable and lucrative appointments, would have the effect of inducing a large number of young officers to devote their leisure time to the assiduous study of some one or more of those branches of knowledge the possession of which would increase their efficiency as officers. In the course of a few years the average standard of attainment would be considerably raised; and the number of thoroughly accomplished officers qualified to perform in the most

efficient manner the varied duties which devolve on the Staff would be greatly increased.

In order to obtain these results, it would of course be necessary so to regulate the standard of attainment as to place the rewards of proficiency within the reach of a considerable proportion of the regimental officers of the army.

This condition I think would be completely fulfilled, were the standard of attainment so regulated as to render it probable that on an average six officers per regiment would be able to earn an addition of one shilling per day to the pay of their rank; three officers an addition of two shillings, and one officer of three shillings. Extra rates of pay granted on this scale would cause an expenditure of fifteen shillings a day per battalion, which is a little less than the pay of three ensigns, and a little more than the pay of fourteen privates.

In endeavouring to estimate the effect of introducing a new measure into an established system, the probability of its combining harmoniously with the other parts of the system is a consideration to which it is most important that due attention should be given.

In the British army, as in all other armies, conspicuous bravery and conspicuous military talent, when service in the field affords opportunities for their display, always secure distinction and reward. But in time of peace, money is the only qualification recognised as giving a prior claim to promotion. Distinguished abilities or superior attainments in no way contribute to professional advancement.

Among those who hold commissions in the army are many who, beyond that amount of knowledge necessary to carry on the routine duties of the arm to which they belong, know little and care less about military matters; many who, finding ignorance and want of zeal no impediment to their rising to the highest rank in the army, are utterly averse to sacrifice their ease, or to interrupt their favourite pursuits, in order to devote their time and their energies to the acquisition of knowledge which they consider as not likely to be productive of any practical benefit. Not a few of these officers, by long habits of idleness and self-indulgence, have rendered themselves unfit for any intellectual exertion. They have become quite incapable of making that effort of will necessary to keep the attention steadily fixed on any object for a considerable length of time. Officers of this character form a very numerous class in the senior as well as in the junior ranks of the army; and such being the case, it is obvious that any attempt to raise the standard of attainment by means of a compulsory character would have to contend with many obstacles. Not only would such an attempt be very unpopular, it would meet with much practical opposition of a very effective kind.

In many corps, the feeling of the commanding officers would be hostile to compulsory measures; and if the officers commanding those corps did not dare actually to oppose such measures, they would use no exertions to carry them out.

In other corps, where the commanding officers might be well disposed to carry them out, it might sometimes happen that they were not qualified to do so. Not being themselves sufficiently instructed, they would fail in their

efforts to instruct others. In other cases, it might happen that a zealous and thoroughly instructed commanding officer, by carrying out his measures with too great stringency, would create so much disgust as to defeat his own object.

These are some of the considerations which seem to render it inexpedient, if not altogether impracticable, to enforce the possession of any high degree of educational attainment, as an indispensable qualification for promotion. Measures based on the principle of offering inducements to voluntary exertion would have no difficulties of this kind to contend with; no extra duties, no compulsory labours, would be imposed upon any one; there would therefore be no motive for opposition. On the contrary, every individual in every rank of the army would be interested in the success of measures which, without coercing idleness or imposing penalties on incapacity, recognised the claims of zeal, of industry, and of talent, and which offered a sure reward to every species of military acquirement.

Any measures framed in accordance with this principle would not only disarm opposition, they could not fail of conciliating a large amount of active support; nor would such measures be liable to the risk of failure from the negligence, the incapacity, or hostility of the agents employed to carry them out.

The most perfect system of compulsory training, unless administered with energy, intelligence, and zeal, will soon degenerate into a formal routine; but there is no danger that the voluntary exertions of those who strive for a promised reward will relax, however incompetent or indifferent the persons may be who are appointed to decide who is to receive that reward.

Almost every one of the observations which I have had the honour of submitting to you, have been suggested to my mind by looking at the conditions of military service in time of peace from that particular point of view which takes cognizance of the relations subsisting between these conditions and the feelings and interests of individuals.

The result of a survey from this point of view is to disclose a defect and to suggest a remedy. The want of any motive to stimulate individual exertion, is in time of peace the great disadvantage of a military career. This is the defect. The obvious remedy is to devise expedients for making each individual officer and each individual soldier feel that some special distinction or advantage may be procured by his own exertions.

Those particular measures which I have discussed in detail, and which I have endeavoured to show are fitted to accomplish this purpose, are seven in number, viz.:

1st. The classification of soldiers according to their skill as marksmen, and the grant of extra pay to all in the first class.

2nd. The distribution of premiums for every point made at target practice.

3rd. The payment to the officers and non-commissioned officers entrusted with the direction of musketry instruction of an allowance varying according to the figure of merit of their corps.

4th. The institution of periodical trials of skill, and the distribution of prizes for excellence in rifle-shooting, swordsmanship, horsemanship, and athletic exercises.

5th. The grant to officers of extra rates of pay for special attainments.

6th. The affiliation with the Staff of the army of all officers who reach a certain standard of attainment.

7th. The selection for appointment on the Staff of those officers who are the most distinguished for their abilities, for their attainments, and for their services.

It will be perceived that in the fourth and seventh of these proposed measures—namely, those which relate to the institution of periodical trials of skill and to the selection of officers for Staff appointments—the principle by which merit is estimated and rewards distributed is competitive, and has reference to a variable standard. The nature of this principle is to restrict, within fixed limits, the number of individuals who can derive direct benefit from these two measures.

In all the other measures the principle of estimate and distribution is absolute—it has reference to a fixed standard, and admits of an unlimited number of individuals participating in the benefits of each of the different measures.

The practical effect of these measures would therefore be to render a certain addition to the allowances of officers and to the daily pay of privates contingent on successful exertion—to make each individual feel that, whatever may be his rank, and whatever the nature of his duties, if zealous and efficient he will receive more, if careless and inefficient he will receive less.

The importance of measures such as these, and the effect they are likely to have in increasing the efficiency of the training of the army, is to be estimated by considering the nature and amount of the influence they are calculated to exert on the disposition with which soldiers regard the work of instruction, by considering what influence they are likely to exert in counteracting feelings of apathy and dislike, what influence in promoting energy and inspiring zeal.

It is manifestly of the greatest importance to render not only as efficient as possible, but also as attractive as possible, the training of an army which is numerically weak, and of which the limited establishment is with difficulty maintained effective, because the name of no soldier is inscribed in its muster rolls without his own consent.

Evening Meeting.

Monday, February 18th, 1861.

Captain E. G. FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the INSTITUTION between 1st January and 18th February, 1861.

LIFE.

Bagot, Geo., Capt. 69th Regt. 9*l*.
Bateman, H. W., Ensign 31st Regt. 9*l*.
Beazley, Geo. G., Lieut. 83rd Regt. 9*l*.

ANNUAL.

Adye, John M., C.B., Col. Royal Art. 1*l*.
Antrobus, E. C., Capt. 50th Regt. 1*l*.
Balfour C. J., Comr. R.N. 1*l*.
Beames, P. T., Lieut. 69th Regt.
Bent, Chas., Lieut. Royal Art.
Blair, James, Capt. Mad. Art.
Brady, T. C., Staff Surgeon. 1*l*.
Buckle, C. H. M., Capt. R.N., C.B. 1*l*.
Burgoyne, Hugh T., Comr. R.N. 1*l*.
Byham, W. R., Esq. War Office. 1*l*.
Cavendish, H. G., Lieut. 68th L.I.
Chermside, H. S., Major Royal Art.
Clarke, M. de S. McK. G. A., Lieut. 50th Regt. 1*l*.
Codrington, Wm., Lieut. R.N. 1*l*.
Cody, Wm., Lieut. 3rd. W.I. Reg.
Cotton, Thos. F., Staff Surgeon
Couchman, W. D., Capt. H.M. Beng. Art. 1*l*.
Dawson, Hon. Vesey, Lt. Cold. Guards. 1*l*.
Deane, H. C., Lieut. 2nd Batt. 17th Regt. 1*l*.
Deshon, Edward, Lieut. 68th L.I. 1*l*.
Edgell, A. Wyatt, Cornet 10th Hussars. 1*l*.
Gipps, F. B., Ens. 35th L.I.
Good, James, Asst. Surgeon 43rd L.I.
Gorman, W. J., Capt. Ceylon Rifles
Grant, J. M., Lieut. 85th K.L.I.
Harkness, J. G., Capt. 2nd Batt. 5th Fus.
Jones, A. S., Major 13th P. A. O. L. I. 1*l*.
Jones, Lewis T., Rear-Adm. 1*l*.
Jones, Loftus F., Lieut. R.N. 1*l*.
King, W. G. N., Capt. R.N. 1*l*.
Kingston, A. J., Comr. R.N. 1*l*.
Layard, W. T., Col. Ceylon Rifles.
Lodder, W. W., Lt.-Col. 59th Regt.
M'Clure, Sir Robert J. Le M. Kt., Capt. R.N. 1*l*.
Mure, C. R., Capt. 43rd L.I.
North, R. M., Major H.M. Indian Army.
Oldfield, R. B., Comr. R.N. 1*l*.
Osmer, Jas. J., Lieut. 69th Regt.
Phibbs, Owen, Cornet 6th Drag. Gds. 1*l*.
Pocklington, F., Capt. 2nd Batt. 5th Fus.
Preston, H. E. W., Lieut. 50th Regt. 1*l*.
Randall, Alfred, Ens. Ceylon Rifles.
Rollo, Hon. R. Col. C.B. Mil. Secretary, Canada. 1*l*.
Rowsell, E. P., Ens. London Rifle Volunteers. 1*l*.
Scott, W. H. H., Assist. Mil. Storekeeper, Cape of Good Hope.
Shanks, Hemsley H., Sec. H.M. Ship Hannibal.
Sheil, John, Ens. Ceylon Rifles.
Stanton, Wm., Comr. R.N. 1*l*.
Stone, C. J., Ens. 35th L.I.
Trafford, H. T., Capt. 43rd L.I.
Tryon, R., Capt. Rifle Brigade. 1*l*.
Vandespar, W. C., Major Ceylon Rifles.
Watson, R. C., Capt. Ceylon Rifles.
White, W. R., Lieut. 50th Regt. 1*l*.
Yeo, Gerald, Surgeon R.N. 1*l*.

SWISS TARGETS AND RIFLE RANGES.

By Mr. John Latham.

At the prize meeting of the National Rifle Association, held at Wimbledon in July last, it may be remembered that considerable interest was excited by the presence of a deputation from Switzerland, a country where rifle shooting has been the favourite pastime of the people for centuries, and where its prevalence has been justly considered as one great safeguard of their country, and of the liberties they enjoy. This deputation creditably supported the reputation of the Swiss for skill in shooting, having won thirteen of the prizes open to them, shooting at all distances up to 900 yards, although they had to contend with many disadvantages, their own weapons being detained in France, and the English rifles with which they fired being very different in many important respects from any they had previously been accustomed to. They returned to their own country delighted with the reception they had experienced, and struck with the novelties they had witnessed. They told their countrymen that England had indeed made a step in advance, and that it was the step of a giant. Themselves accustomed to, and expert in shooting at the ranges previously considered as the extreme limit of rifle shooting, they had seen, for the first time, targets placed at half a mile and upwards, distances at which, to quote the words of one of them, "The target of six feet square appears on the front sight of the rifle as an inappreciable point which the slightest movement displaces in all its extent."

It happened that the majority of these Swiss were from the Canton of Geneva, which is a favourite resort of our countrymen, and, many English families being resident there, the fact of our first national rifle meeting was probably better known than in other parts of Switzerland. It was resolved that at the next cantonal shooting match, which would take place on the 29th of August, a day should be devoted to rifle practice at the longest range available, viz. 703 yards. Lord Vernon, who was at Geneva when this announcement was made, commissioned me to attend this meeting and report upon the arrangements employed. Unfortunately, I found upon my arrival that he was detained by illness at Wiesbaden, which circumstance caused universal regret, he being so greatly esteemed throughout Switzerland on account of the interest he has always taken in the rifle matches, where he has frequently appeared as a competitor and winner of many of the prizes.

The shooting took place at the "Plan des Ouates," a large field on the road to Carouge, about twenty minutes from the town. It had been organised especially with a view to a comparison of the shooting of the

English rifles obtained as prizes with the Swiss Federal carbine and rifle; but this expectation was disappointed. Only two English rifles were present, with one of which, however, the second prize was obtained. The targets were four in number, placed in front of a small hill, which was excavated so as to form a natural butt some 30 feet in height. I was much struck with the exactitude with which the shots were recorded. As soon as the bullet had reached the target, the precise spot where it had struck was indicated by a large disc, or "marking bat," about 18 inches in diameter, coloured black if the hit were an outer, and white if the ball had touched the centre. If the ball had passed over the target, the bat was moved vertically up and down. A ricochet was indicated by a horizontal waving movement in front of the target, and a similar movement on the right or left of it showed that the ball had passed in that direction. Now, in all our shooting at the long ranges, the chief difficulty we find is, that no notice is taken by the marker of those shots which miss the target. We cannot tell, therefore, in what direction the bullets are going, or what allowance to make in order to obtain greater precision. By the Swiss plan, if the ball has struck the target, we see the exact distance to the right or left, and know precisely what allowance to make in our next shot. If it has missed altogether, we know in what direction the error lies, and can correct it, though not so accurately. It is true that the position of the signal-flags in our system is supposed to give the same guide as to the direction the shots are taking; but when, for instance, a "right outer" is shown, it may be within an inch of the centre, or just on the edge of the target, and we are left to guess within three feet as to the allowance to be made the next time we fire.

Towards the close of the shooting I obtained permission to go up to the targets, and on reaching them it was at once evident how this great exactitude in marking was possible. A covered trench, some seven feet in depth, was dug, or rather thrown up in front of the targets, and in this trench the markers were placed so that they not only saw clearly every part of the targets, but could lay their marking-bat exactly on the bullet hole without exposing themselves to the least danger. Of course, such a position in front of an iron target would be very dangerous—in fact, impossible; but these targets were made of a frame of wood covered with canvas and paper, so that the bullet, instead of being split to pieces by the concussion, passed easily through them, leaving a small hole as evidence of its path, and was received almost uninjured in a heap of logs of wood placed just in front of the butt, and behind the targets. The targets were made to descend into the trench by means of a rope and pulley, and were repaired by pasting a small piece of paper over the hole made by the bullet. Thus, there was no time lost in colouring the target, and there being only one bullet mark there was no chance of error or confusion on the part of the marker. The economy of this plan is twofold. In the first place, a single-frame target, 6 × 12 feet, with ropes and pulleys, can be made for £3; or a double one, which is the kind generally employed, for less than £5; whereas an iron target of the same size costs, according to the War Office estimate, £13 10*s*., or from any private manufacturer, about £18. In the one case the lead is dug out almost uninjured; in the other it is split into thousands of fragments, which fly about in all directions, to the great danger of the markers, and must necessarily prevent them from keep-

ing that close watch on the target which is requisite to mark the shots with any degree of exactitude. It is true that the iron target is by far the most durable; but even iron is not everlasting, and when cracked it cannot be repaired; whereas a wooden frame can always be mended in a few minutes and for a few shillings.

The ground where this shooting took place was usually employed for artillery practice, and was traversed by two breastworks, one at either end, from the first of which the competitors fired. The other was about ninety yards in front of the targets, and this served to intercept, and almost entirely prevent all ricochet. This would be a matter of the greatest importance in our own ranges, where ricochet shots form the principal danger. A few words of explanation will show the simplicity and efficacy of this plan. A ricochet shot is one which is fired at too low an elevation, either from accident or from incorrect sighting of the rifle, and therefore, the bullet striking the earth, not point foremost, but sideways, and continuing its onward motion, it is deflected or thrown up at a fresh angle of elevation, either striking the target or the butt in its further progress. Now, we can calculate the lines within which every ricochet bullet must pass, from the muzzle of the gun until it touches the earth, and we find that the majority of such shots strike at distances ranging from 100 to 40 yards in front of the target. If, therefore, we raise a bank of soft earth at about 90 yards, and slope it at such an angle as to catch the point of the bullet instead of the side, the ball will go *into* the bank of earth so placed, instead of glancing from it. Of course either the targets must be raised so as to be visible above this bank, or else the shooter must be placed at an elevation so that he can see over it. In the Swiss plan the raised trench for the markers effects this object, and serves also as a second ricochet bank close to the targets.

The shooting closed at seven o'clock, and in less than half-an-hour afterwards the targets were dismounted, packed in a cart, and driven off. This facility would be of service in country places where the targets are only used once or twice a week, and would be liable to damage from weather, &c. if left standing.

It is obvious that these targets are in some respects not so well adapted for military purposes as the iron targets; for instance, for file and volley firing, comparing and verifying registers, &c. there would be some difficulty; but for match shooting, or ordinary practice, they are an inexpensive and efficient substitute for them.

The ordinary shooting ground of Geneva is situated at the Coulouvrenière, a suburb of the city, and is surrounded by workshops and buildings; whilst behind the butts is a short strip of market gardens, and several cottages, whose inhabitants may frequently be seen at work in the fields while the firing is going on. The precautions which are taken to avoid accidents or danger from stray bullets are very ingenious, and so successful, that in an open carpenter's workshop and a watch factory, both looking on to the shooting ground, and within a few yards of the targets, I saw several men pursuing their work, quite undisturbed by the shooting or the bullets passing in front of them.

The arrangement of the targets is the same as at the longer distances, but of course upon a much smaller scale. The same canvas-covered frames

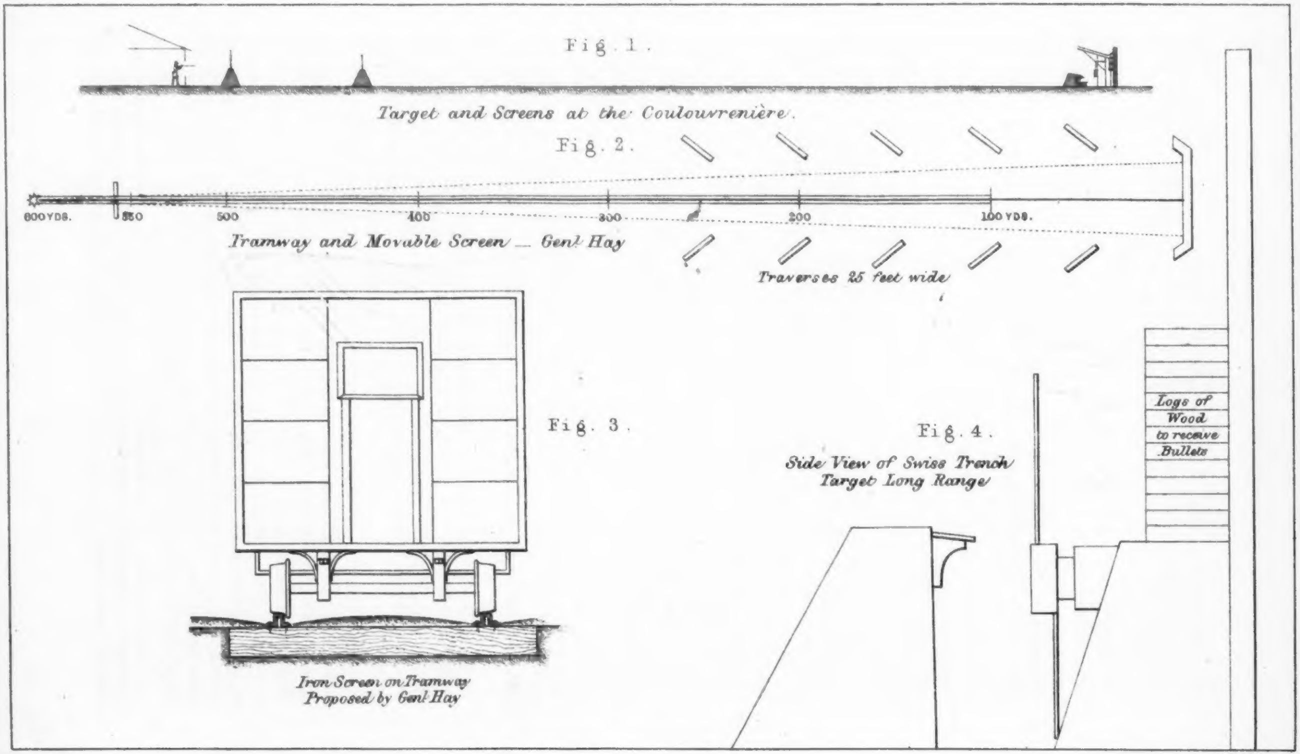


Fig. 1.
Target and Screens at the Coulouvrenière.
Fig. 2.
600 YDS.
550
500
400
300
200
100 YDS.
Tramway and Movable Screen — Genl. Hay
Traverses 25 feet wide
Fig. 3.
Iron Screen on Tramway
Proposed by Genl. Hay
Fig. 4.
Side View of Swiss Trench
Target Long Range
Logs of
Wood
to receive
Bullets

J.R. Jobbins.

are used, and the logs of wood behind to receive the lead. There is in addition a covering to protect the targets from the weather, this being a permanent and not a temporary erection. The same earthern bank is used to intercept ricochet shots, and in addition a second bank rather lower, and these are placed at distances of 10 and 40 yards from the shooter, who fires from a covered building or stand, as it is called (fig. 1.) Above each of these ricochet banks is a stone wall about 20 feet high, and the depth of which is calculated from the trajectory, so as just to allow sufficient space for any ball fired at the right elevation for the target to pass under it. If the shot is fired at an elevation which would cause it to pass over the target, it is immediately stopped by the first or second screen. If the elevation is too low, it is stopped by the ricochet banks under each screen. The stone employed is of a very porous kind, so as not to allow the ball to glance off, but having sufficient cohesion to completely arrest its progress even at 10 yards from the muzzle.

A very remarkable feature in these arrangements is the great economy of space. In a width of 60 yards, upwards of 24 targets are placed, the distance between each being only one yard. To avoid confusion, the space below each screen is boarded up, except a small opening about a foot square opposite every target; so that the shooter in firing from his position at the "stand" can only see the one opposite to him, and consequently cannot aim at any target but his own.

An objection has been raised to these screens on account of the smallness of the openings, which, it is urged, serve as a guide for the eye in aiming, so that a man may become an expert shot in a range fitted up in this manner, and yet be unable to shoot well in the open country where he has no such assistance. In fact, since no bullet which passes through the opening can miss the distant target, it is said that, in reality, it becomes a question of firing through a square of 12 inches at 10 yards, instead of hitting a target of 4 feet at 200 yards. To this objection it may be a sufficient answer to reply, that practically it is not found that any such difficulty results. Screens of a similar kind are universal in Switzerland, and in some parts of Belgium and France, and the universal testimony of those who have tried them is that this supposition is incorrect. Certainly the Swiss who visited us at Wimbledon, hardly one of whom had ever fired in an open range before, did not seem to be much embarrassed, since they carried off five prizes out of seven at the 200 yards' range.

But, if the smallness of the opening be considered an objection, it is avoided in a plan proposed by Mr. S. R. Lock, of Regent Street, and published in the 24th number of "Once a Week," dated 10th December, 1859, from which the following description is quoted:—

I propose to erect a wall, of a concave form, 20 feet high, and about 25 to 30 feet in length. In the centre of this the target would be placed; and to prevent the possibility of any inexperienced beginner missing the wall, I would build another wall of nearly the same size, of woodwork, faced on the side nearest the marksman with mud or pisé, to prevent the rebound of the bullets.

This wall should be placed 25 yards from the rifleman, and should have in the centre a hole or doorway cut, six feet three inches high, by two feet broad. If the marksman at 25 yards fired a bullet through this opening, it could not possibly diverge so much as to miss the distant butt. It would be almost impossible for any man, however awkward, to miss the near butt altogether, but even this chance of accident may be further provided

against by the form of the shed which might be erected for the protection of the marksman from the weather.

These walls and the other erections might easily be built so as to be ornamental rather than otherwise.

The apparent objection which presents itself to this plan is, that the act of firing through a comparatively small opening at a distant object, would too much facilitate the aim, so that a marksman would soon become an adept with such assistance, and yet be unable to shoot well in open country. This, however, *is not the fact*, as actual experience will prove.

Indeed, upon reflection, it must be obvious, that as not only the target, but nearly the whole of the distant butt will be visible through the opening, it will require quite as much care to aim successfully as if the target stood alone.

Upwards of twelve months since a plan was proposed by General Hay for the construction of Rifle Shooting Grounds in populous places, which met the approval of the Secretary of War. Through the kindness of the authorities I have obtained permission to inspect the plans at the War Office, and to make the accompanying diagrams, by which you will see that it is free from either of the objections I have mentioned; as the opening in the screen is large enough to admit a full view of the whole of the butt as well as the target, and the screen itself is movable to any distance from 100 to 600 yards. Being accompanied by an estimate of the cost, and applicable to any targets and butts already constructed, it is especially valuable to Volunteer Rifle Corps, and I trust the Government may be induced to expedite the publication of it.

General Hay proposes a wrought-iron screen twelve feet square (fig. 3), having a central opening three feet wide, with a sliding top piece by which the height may be varied from five to seven feet, according to the distance and the trajectory of the arm employed. This screen moves upon a railway (fig. 2), so that it may be adjusted to any distance from 100 to 600 yards, and the shooter always fires from 40 yards in front of the opening. At distances varying from 50 to 250 yards from the butt, traverses 25 feet wide are erected at the sides, and serve to intercept stray bullets which may pass outside the screen.

Supposing the tramway to be 400 yards in length, General Hay calculates that it may be laid down from old rails and sleepers which have been condemned by the railway companies and may be obtained at a cost not exceeding £27 per 100 yards. This would give for the cost of the tramway £100, and the screen of three-eighths wrought iron with framework and wheels might be made for £100, making the cost of such a range £210 in all, exclusive of the butt and traverses, which may be made of brickwork or earth and timber, whichever may be cheapest in the locality where it is erected.

In the target recently invented by Mr. Chevalier the difficult problem of employing electricity to register the position of the shots upon an iron target appears to have been satisfactorily solved. By means of an indicator placed on the right of the shooter, he can read off the position of his shot the instant after he has touched the trigger, and even before he can hear the sound of the bullet striking the target. All the attempts previously made to construct an efficient electric target have failed, on account of the mechanism employed to break and make contact being liable to derangement from the great force of the concussion of the bullet. Mr. Chevalier obviates this difficulty by a very ingenious and simple contrivance, and his targets,

which are now under trial by the authorities at Hythe and Aldershot, appear to answer perfectly. The cost of them, however, which at present varies from £30 to £60 according to the size, will in a great measure prevent their general adoption.

In all the published accounts which speak of the comparative merits of Swiss and Enfield Rifles, a very great superiority in point of accuracy of shooting is claimed for the Swiss weapon. In fact, it is always described as being the most accurate of the military weapons in use. In "Rifles and Rifle Practice," by Lieutenant C. M. Wilcox, of the United States Army, published in 1859, which is certainly the most compendious and exact work on the subject which I have ever seen, it is thus stated at page 189:—

In 1855, experiments were made with the two Swiss rifles, the Baden rifle, Belgian, Prussian, and Enfield rifle muskets. The result of these experiments was a marked superiority in favour of the two Swiss rifles.

At 654 yards the Enfield rifle placed 40 per cent. in a target 9 by 12 feet; at 818 yards the Federal rifle placed 96 per cent. in a target 8 by 8 feet, and the entire 100 balls in a target 10 by 13 feet. . . . . . . At 990 yards in a target 10 by 19 feet, the Federal rifle put 85 per cent. of its balls; at 1,308 yards the Federal rifle put 47 per cent. in a target 10 by 19 feet . . . . . . These experiments proved that the two Swiss rifles were greatly superior to the others tried, both in range and accuracy.

And again at page 247 he compares the shooting of the Enfield rifle with that of the Swiss, greatly to the disadvantage of the former:—

In the experiment at Hythe, in 1856, the effect of the Enfield rifle upon a piece of artillery, with its men and horses, was shown to be such, that it would be impossible for a field battery to remain in front of infantry at a distance of 810 yards for ten minutes; *three minutes* alone sufficed at that distance for 30 files to wound the men and horses to such an extent as to disable the piece. *With the more accurate Swiss rifle at that distance the destruction would have been more rapid and complete; and at a distance of* 1,312 *yards it would have inflicted the same, or even greater, damage than the Enfield rifle at* 810 *yards.*

I have quoted from Lieutenant Wilcox's book, as being the latest as well as the best work on Rifle Practice; but the same opinion is expressed in nearly every foreign work on the subject, and curiously enough the only testimony in favour of the English rifle comes from a Swiss. In M. Wessel's work, before quoted, he gives, at page 23, as the result of his observations:—

At 200 or 300 yards the regulation Swiss musket and rifle are good arms, their shooting is certain, and a little wind has not much effect upon them. But at the distances of 500 and 600 yards, and of necessity therefore at those of 800 and 900 and 1000, the English arms have an incontestable superiority over ours, and most of our shooters availed themselves of those which the kindness of the English riflemen placed incessantly at their disposal.

This is distinct enough, and on the very next page we read:—

The Enfield is a rifle which resembles more than any other the arms with which we are acquainted in Switzerland. I was not able to examine it sufficiently to give a detailed description of it, but its effects in power and accuracy are surprising enough. It was three of the ordinary regulation Enfield rifles loaded with the government service cartridges which contested with a perfect equality against the heavy target rifle, furnished with hair trigger and American sights, at the prize given by Miss Burdett Coutts. This really astonishing result proves at once both the excellence of the arm, and the extreme skill of the three riflemen who made so good use of it.

I must trouble you with a third quotation from page 26, as it bears upon a point which I shall have occasion to notice presently:—

There was blowing at Wimbledon a wind which, without being violent, was very sensible during the whole time of the shooting. This wind, which entirely displaced the path of our small Swiss bullets, produced no effect upon the heavy cylinders of the Lancaster and Whitworth bullets; and, notwithstanding the wind, it was not necessary at 500 yards to take aim off the target—had we done so the shot would have missed.

How are these contradictory accounts to be reconciled? or, rather, which of them is correct? I am not going to attempt to prove to you that the very black picture of Lieutenant Wilcox is just the same thing as the very white one of M. Wessel; but I must own that I prefer the opinion of a practised rifle shot, drawn from his own experience in actual competition, to the comparative results of the Belgian experiments, however carefully conducted. It has been suggested, also, and with great reason, that either the Enfield rifle, or the shooter, at Beverloo must have been a very bad specimen; since at 650 yards the hits in a target 9 by 12 feet are only 40 per cent.; the Hythe average for the same distance being 40·46 per cent. for a target just two-thirds of the size.

I have here on the table specimens, from the Museum of the Institution, of the latest model Swiss carbine and rifle as well as the Enfield rifle. You will see that the Swiss arms, though shorter and smaller, are heavier than the Enfield; but the principal difference is in the calibre and rifling. The Enfield rifle has a bore of ·577, and the turn of the rifling is six feet six inches, that is, the bullet makes one revolution in that distance. The bullet weighs 530 grains. The Swiss rifle has a much smaller diameter, ·413, and a quicker turn, viz. once in three feet. In both these particulars it approaches nearer to the Whitworth rifle, which is acknowledged to be far more accurate than the Enfield; the bore of the Whitworth being ·451, and the spiral one turn in 22 inches. But both the Whitworth and Enfield bullets, which weigh 530 grains, are fired with a charge of only 70 grains of powder, and the Swiss bullet weighing 260 grains is fired with 62 grains of powder. We may assume that this enormously increased charge must start the Swiss bullet with a much greater velocity, and (other conditions being equal) increase of velocity gives increase of accuracy, or, as we may say, the bullet going up more swiftly, has less time to go wrong; and therefore, in a closed range, or on a still day, we may expect the Swiss rifle to make a better score than the Enfield. But in a strong wind its lightness is a disadvantage, and it is more easily affected than the Enfield and Whitworth. This may tend to explain in some measure the great difference in the opinions I have quoted.

I have only to conclude by thanking you for the kind attention with which you have favoured me, and to express a hope that, among the various plans which I have described, some may be found useful either in lessening the expense or the difficulty of obtaining safe rifle practice grounds in England.

In answer to questions, Mr. LATHAM said the bank in front of the marker (fig. 4) served as a second protection, but the actual wall upon which the shooters rely to catch ricochet shots is placed about ninety yards in front of the target. The height of this bank, supposing it to be raised entirely from the surface, would be seven or eight feet, but it is made by digging a trench of four feet, and then throwing up four feet of earth outside; so that the bank, though eight feet from bottom to top, is in reality only four feet from the level outside. When the woodwork behind the target gets well filled with the bullets, it is burnt and the lead is saved. The Swiss go upon one principle in strong contrast to our own; they employ nothing but woodwork or turf, or something which will not split the bullet up.

THE CHAIRMAN: Did the Swiss gentlemen actually try their own rifles against the Enfield? Was it the result of actual experiment that enabled them to form an opinion in favour of the Enfield in contradistinction to their own?

Mr. LATHAM: When they came over here their own rifles were detained in France, and it is a curious thing that on their return the rifles which they won here as prizes were also detained in France.

THE CHAIRMAN: From your experience of the comparison, was it the same man who used both descriptions of weapon?

Mr. LATHAM: No; it was merely what I saw from the firing.

THE CHAIRMAN: You cannot say whether the difference in the firing was not the result of difference in the men?

Mr. LATHAM: No, I cannot, except that the man who gained the second prize used the Enfield rifle.

Mr. W. F. HIGGINS: At longer ranges they would certainly take our rifles.

Mr. LATHAM: Yes; yet it is stated in all works upon the subject that the Swiss rifle is much more accurate than ours. Here is an account of the practice at 1,320 yards, but the long range practice I saw did not exceed 700 yards; and that is why I was so much surprised to find it laid down everywhere that the Swiss rifles are so much superior to our own. It is contradictory to the testimony of the Swiss themselves.

THE CHAIRMAN: Yet the flattened trajectory of the Swiss bullet would rather argue in favour of the Swiss rifle; and the smaller size of the bullet also, would be in favour of greater accuracy.

Mr. LATHAM: The Swiss bullet weighs 260 grains, and the weight of powder is 62 grains; the weight of the Enfield bullet is from 480 to 530 grains, and the powder 70 grains; the weight of the Whitworth bullet is 530 grains, and the powder 80 grains. It is evident that the Enfield bullet is under a very great disadvantage compared with the Swiss bullet. It has a larger diameter to offer resistance to the air, and yet it is started with less force than the other. The turn of the Swiss rifle is very much quicker, which would also tend to give it greater accuracy. Yet we have the evidence of the Swiss themselves that they were astonished at the accuracy of the English rifles.

THE CHAIRMAN: I would certainly suggest the propriety of further experiments to ascertain the relative merits of the two kinds of rifle.

Mr. W. F. HIGGINS: I think that question has been decided. There is a

very good authority for the superiority of the Enfield over the Swiss. Colonel Wilford mentions that the Swiss carbine was tried at Hythe, and the results were far inferior to the Enfield.

Mr. LATHAM: I was not aware of that. The heavy Swiss rifles, which are of recent date, are enormously heavy, some of the barrels weighing as much as 25lb. They have a small padded cushion, which the man holds in his left hand, supporting his elbow on the hip. The object of the weight is that there should not be the slightest recoil. A child might fire without experiencing any recoil.

Mr. W. F. HIGGINS: But very often they use rests; at least, I have seen them used in Germany; they merely put the rifles on rests, for they are so heavy that they cannot be used without.

Mr. LATHAM: It is not so in Switzerland. When they shoot for prizes, they must shoot from the shoulder. The rifle is laid on the barrier from which the shooter fires. It is so heavy that the men cannot hold it long. The man just goes up, lifts the rifle, fires it, and drops it down directly. None of these men who fire for the higher prizes load their rifles. The exertion of loading would derange their nerves, and they always have a special loader. The young men do not fire with the heavy rifles; it is generally the experienced shooters who use the heavy rifles. The marksmen always stand or lie down; they have no kneeling position similar to ours. The two highest prizes were won by firing from the shoulder standing, at 700 yards. M. Thorel, who won the highest prize at 703 yards, would have made upon our plan seven points at 700 yards. The target itself was rather larger. We keep the same height, six feet, which is estimated to be that of an infantry soldier, for all distances; so that the long range target represents the width of six men standing abreast. The Swiss allow for such a distance a height of nine feet, which is estimated to be the height of cavalry. I saw some extraordinary shooting there. One man, at 500 yards, lay down as though he was going to sleep; he laid his head on his arm, and placed his rifle-stock along his cheek. The rifle must not rest or touch upon anything but the man's body, which may be in any position he likes.

Mr. W. F. HIGGINS: How many grooves has the rifle?

Mr. LATHAM: The two muskets differ in that respect. The long rifle has four grooves, and the short rifle has eight; the bullet fired from both is the same. I have tried both rifles. The accuracy is very great for shooting, and they are very comfortable to fire with. I first put the rifle to my shoulder as we do in England, but I found the projections at the butt end unpleasant. I fired once or twice, and then I fired in the Swiss method from the fore arm, and I liked the shooting very much. Several of the men who were firing there were men who worked in the fields and in blacksmiths' shops. Seeing the extraordinary delicacy of the triggers with which they fired, I was rather surprised, and I asked one of them how they managed to get the fineness of touch necessary. "Oh," says he, "when I am going to shoot, I just put my finger on the grindstone;" and he actually showed me where he had got the white skin.

THE CHAIRMAN: I must say that I am not quite convinced, notwithstanding Colonel Wilford's decision. I do not profess to know anything about rifles: I only fired a rifle once in my life. But we cannot get rid of laws, and there is a distinct law with respect to the formation of the bullet,

and the flatness of the trajectory cannot well be got over. I think Colonel Wilford's opinion in nullified by the report of the American officer, Captain Wilcox, and our Yankee brethren are very acute. I do not desire in the least to disparage the Enfield, but I think we ought to have experiments carried out with the view to get the best instrument that can be made. We are living in peculiar times. This is an important subject, and one which we cannot consider too much. We are much indebted to Mr. Latham for bringing it forward.